ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 65. No. 13. 220 Broadway, New York, March 30, 1911.

TABLE OF CONTENTS.

LEADING ARTICLES: Page.

The Extension of the Sweetwater Dam (illustrated); James D. Schuyler, M. Am. Soc. C. E. 369

The Waterproofing of Masonry 372

The Milwaukee Bureau of Economy and Efficiency; P. H. Myers 373

The Reclamation Drainage in South Dakota (illustrated); A. B. McDaniel 374

Hydraulic Pressure Tests of Aluminum-Bronze Cylinders (illustrated); H. C. Harpenter and C. A. Edwards 376

A Great Australian Railway Cut-Off (illustrated); [Contributed] 379

A New Design of Steel Tie for Electric Railways (illustrated) 380

Efficiency Tests of a 1,170-Ft. Steam Pipe Line 380

The Prevention of Street-Car Overcrowding in Several European Cities 381

Specifications for a Reinforced-Concrete Railway Water Tank (illustrated) 382

Annual Convention of the American Railway Engineering Association 383

The Solution of the Intake Conduit to the Purity of Lake Water; C. B. Burdick 385

The Purpose and Work of the Underwriters' Laboratories; William H. Merrill. 386

A Reinforced-Concrete Viaduct Between Dallas and Oak Cliff, Texas (illustrated) 392

Lighting the Double Hump Yard of the Missouri Pacific Ry. at Dupo, Ill. 394

A Disastrous Factory Fire In a Ten-Story Fireproof Loft Building (illustrated). 396

Findings of the Court of Enquiry Into the Explosion of a Water-Tube Boiler on the Battleship "Delaware" 396

Notes from Engineering Schools 397

EDITORIAL 387

The Triangle Shirt-Waist Factory Fire—Are Commutation Rates Subject to Public Control?—The State Engineering Department of California—The Relation of Engineering Research Work to the Public Welfare

What is the Condition of the American Street-Railway Industry? 388

LETTERS TO THE EDITOR 390

The Strength of Old Timbers; W. Pagan—Police Administration in Havana; "A. E. K."—The Verb "To Tote" and Southern Colloquialisms; D. M. Andrews—Two Highway Bridge Designs for Comparison (illustrated); Frank H. Clutz—The Swatara Bridge Again; J. N. Bridgeman—Agricultural Engineering; Thomas H. Means—A Heavy Water-Flow Encountered in Driving the Strawberry Tunnel (illustrated); J. L. Lytel—A Method of Giving Centers on Old Curves Without Field Computation (illustrated); J. R. Baylis.

ENGINEERING NEWS OF THE WEEK 397

PERSONALS 398

ENGINEERING SOCIETIES 398

The Extension of the Sweetwater Dam.

By JAMES D. SCHUYLER,* M. Am. Soc. C. E.

Work is now in progress, and practically completed, which will increase the effective height of the Sweetwater Dam, near San Diego, Cal., by 20 ft., and double the reservoir capacity. Before describing it a review of the history of the dam, now 22 years old, will be essential to give a clear idea of the conditions leading up to the present extension.

HISTORICAL.—There are probably few dams in America better known, or visited by a larger number of people every year, than the curved masonry structure located on the Sweetwater River, 12 miles southwest of San Diego, Cal. This is chiefly because it is easily accessible by rail, and is made one of the objective points of daily tourist excursions from the largest resort hotels at Coronado and San Diego. Among engineers the dam is known, because of its slender dimensions, as one of three or four of the most daring structures in the world, depending for its stability largely upon its curved form. It is unique, however, even among these, because of its composite construction.

The dam was started with a bottom thickness of about 10 ft., and was intended to be a retaining wall for an earth embankment 50 ft. high. When this had reached a height of 15 to 20 ft., at an expenditure of $35,000, the writer was placed in charge and changed the plan to a masonry wall with a radius of 210 ft., a height of 60 ft., and a base width of 35 ft., enveloping that portion of the wall already built on the original plan. This structure was built with steps on the down-stream side, and finished with a crest width of 5 ft. Just as it was being completed the management decided on a raise of 30 ft., to a crest elevation of 215 ft. above sea-level. The base was widened to 46 ft., and the crest to 12 ft. The additional masonry was built up from porphyry bedrock to the top on the down-stream side of the constructed wall, and as closely bonded to it as possible. Above Elev. 215 a parapet 2 ft. thick, 3.5 ft. high, was built on the up-stream side to prevent the dam from being overtopped by floods discharging through the spillway.

The dam was completed in April, 1888. During the seven succeeding rainy seasons the annual run-off exceeded the reservoir capacity in four seasons, but the spillway, with a capacity of 1,800 sec.-ft., was never overtaxed until Jan. 17-18, 1895, when the stream reached a maximum discharge computed at 18,150 sec.-ft., filling the reservoir to overflowing as the result of a rainfall of more than 6 ins. in 24 hours over the watershed area of 186 sq. mi. For a period of 40 hours a sheet of water 22 ins. deep passed over the crest of the parapet wall, 380 ft. in length, although all outlets were wide open. A gap in the ridge on the south side of the reservoir whose crest was at Elev. 215 carried off a large additional volume of water.

The dam passed through this trying ordeal without injury to the structure itself, although the erosion of laminated and fissured rock next

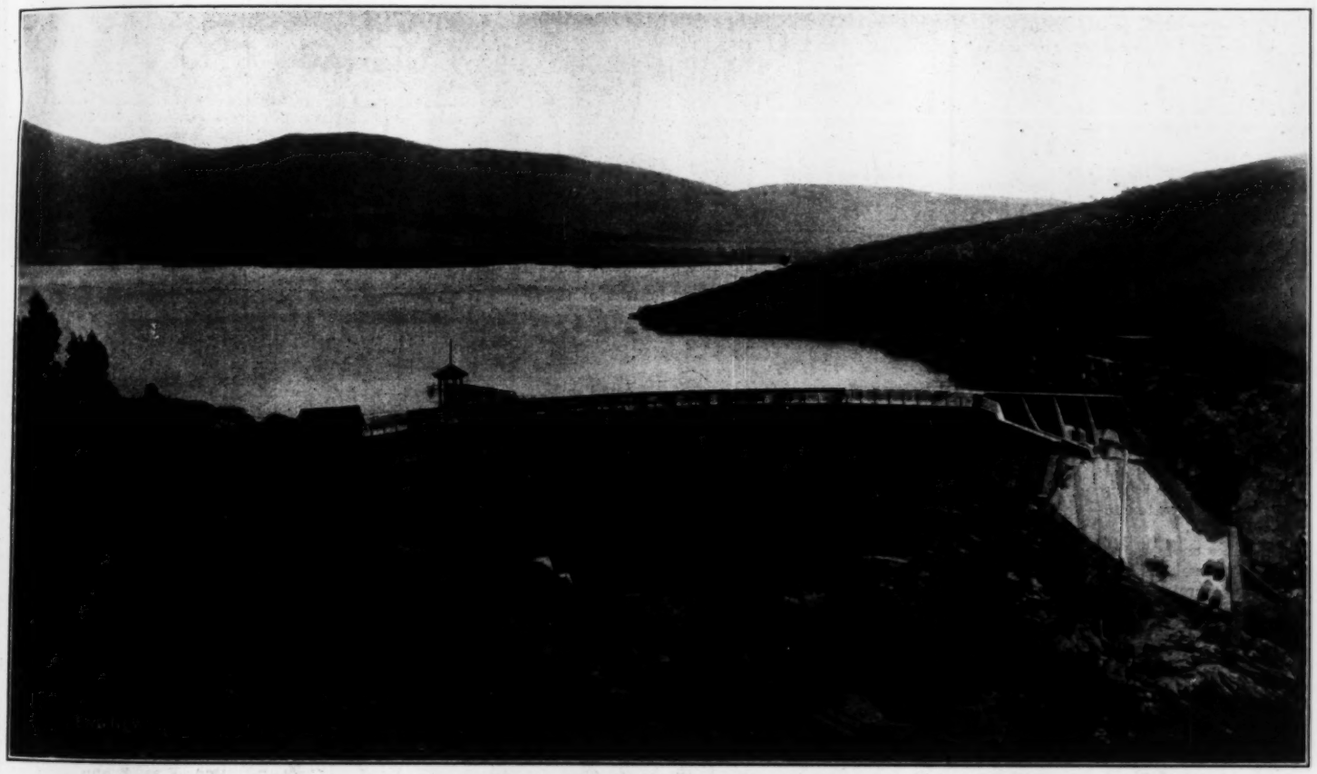


FIG. 1. VIEW OF SWEETWATER DAM, NEAR SAN DIEGO, CAL., ON JUNE 1, 1910, BEFORE BEGINNING EXTENSION.

*Consulting Hydraulic Engineer, Los Angeles, Cal.

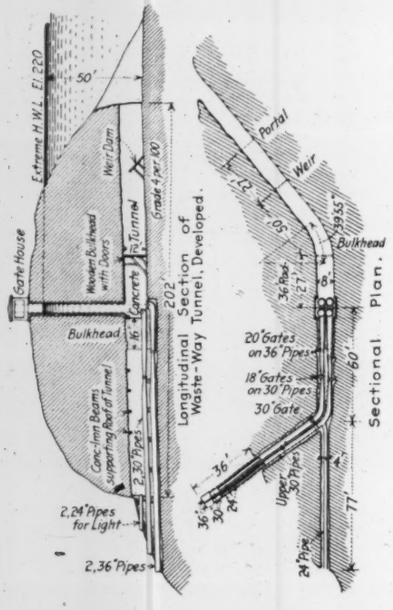
to the spillway was excessive on the south side, and considerable effect at the north end was noted as well, while the pipe line was destroyed for quite a distance below. Not a stone of the dam proper, however, was moved.

The repairs made necessary after the flood, and carried out by Mr. H. N. Savage, then Chief Engineer, with the writer as Consulting Engineer, were as follows:

(1) The parapet was increased in width at its base and raised 2 ft. in height, leaving 200 ft. in the center for an emergency spillway, closed by movable flashboards supported on cast-iron frames. By closing this spillway the storage capacity of the reservoir was increased 25%, from 18,053 to 22,500 acre-feet.

(2) The capacity of the spillway was increased to 5,500 sec.-ft. by the addition of four bays, of 5 ft. each, extending to the level of the new crest, and the apron of the spillway was heavily reinforced with concrete and steel rails.

(3) An unused tunnel around the dam, made



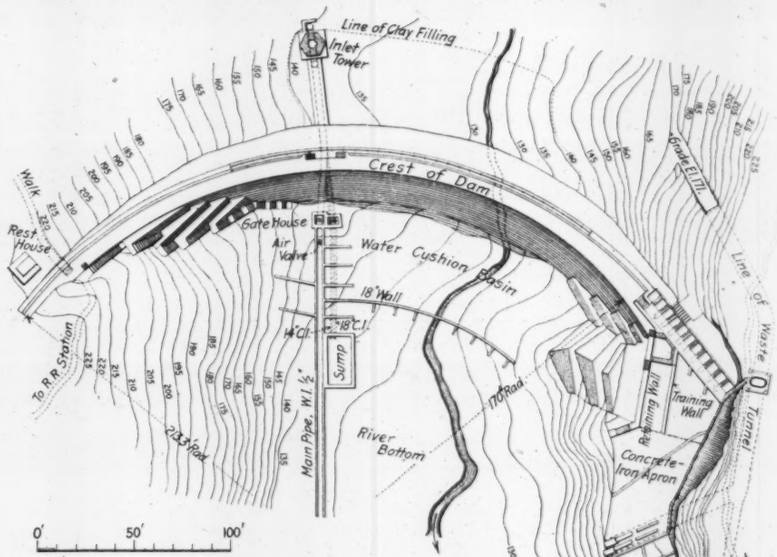


Fig. 2. Sweetwater Dam, as Originally Built. Showing Also Repairs of 1895.

to empty the lake by Court order in early right-of-way litigation, was utilized by laying four pipes through it, two 30-in. and two 36-in.; all four arranged to discharge waste-water in emergency.

(4) A water cushion below the dam was formed by building a reinforced-concrete curtain wall 15 ft. high, 50 ft. away, concentric to the curved face. This wall is only 18 ins. thick, but is supported by buttresses.

The cost of these repairs was about $30,000. [See Fig. 1 for plan of original dam, as repaired in 1895, and the front-page view for the appearance of the dam on June 1, 1910, before the present enlargements begun. The outline of the structure before enlargement may be seen by referring to Fig. 4.]

EXTENSION.—Succeeding the flood of January, 1895, there followed a period of ten extraordinarily dry years in this part of California, during which time the total combined run-off was not sufficient to have filled the reservoir once. After surviving this drought, however, the subsequent flow has been superabundant, and so much valuable water has been wasted from lack of reservoir capacity that the company decided, in the fall of 1910, to extend the dam once more so as to raise the high-water level from Elev. 220.5 to Elev. 235. After acquiring the marginal lands necessary to permit this improvement without flooding private property the word was given to proceed. The writer was again employed to prepare the plans for this extension, and secured the assistance of Mr. A. E. Chodzko, M. E., to make the computations and drawings.

The capacity of the reservoir during the 22 years of service had been reduced by sedimentation from 22,566 acre-feet to 20,360 acre-feet, or nearly 10%. The present extension will enlarge the reservoir to a capacity of 35,000 acre-feet with a surface area of 1,055 acres.

Experience had proven the dam to [illegible] stability and resistance largely in excess [illegible] previous estimates, due to the exceptional [illegible] the masonry, and computation showed that the strength of the wall was due in no [illegible] portion to arch action, by which stresses were transmitted to the side walls. The flood of 1895 had demonstrated how easily the bedrock of the abutments could be stripped off, leaving [illegible] by the erosive force of water, and [illegible] that these abutment walls that had been [illegible] to be immovable were not absolutely [illegible] the logical conclusion was that not only the dam as repaired in 1895 and in [illegible] working height by 8%, be considered [illegible] reached the safe limit of carrying [illegible] that it would be wise in subsequent [illegible] ignore the influence of its curvature, which always remain an asset of stability, of [illegible] yet positive value in future emergencies. In fact, it was determined that the dam in its final shape should be essentially a gravity [illegible] cture.

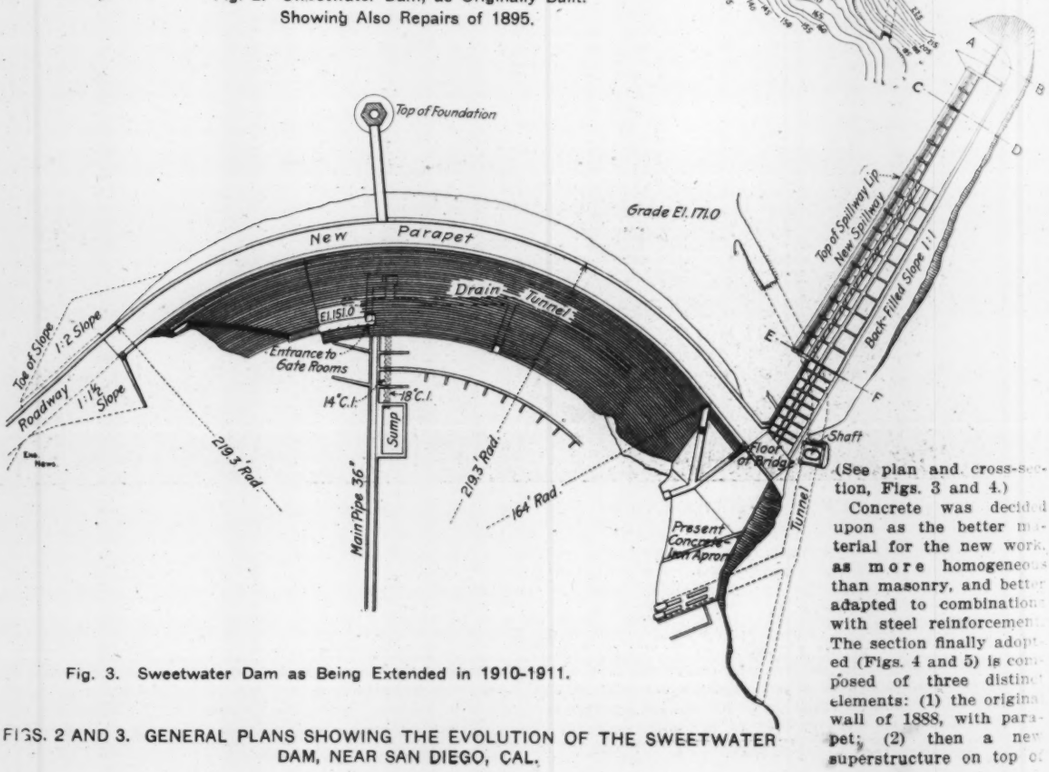


Fig. 3. Sweetwater Dam as Being Extended in 1910-1911.

FIGS. 2 AND 3. GENERAL PLANS SHOWING THE EVOLUTION OF THE SWEETWATER DAM, NEAR SAN DIEGO, CAL.

(See plan and cross-section, Figs. 3 and 4.)

Concrete was decided upon as the better material for the new work, as more homogeneous than masonry, and better adapted to combination with steel reinforcement. The section finally adopted (Figs. 4 and 5) is composed of three distinct elements: (1) the original wall of 1888, with parapet; (2) then a new superstructure on top of

the old wall; (3) and, finally, an additional slab on the down-stream face of the old wall, extending from bedrock to Elev. 216. (See Figs. 5A, 5B and 5C.) In designing the superstructure it was deemed best to eliminate the emergency spillway over the dam, and make the top work a regular reinforced-concrete structure, anchored to the old wall at intervals of 10 ft. by heavy steel rods embedded to a depth of 5 ft. in holes drilled vertically into the masonry. A 12-ft. roadway is carried across the dam between parapet walls, reaching to Elev. 240, or 5 ft. above spillway level.

Inasmuch as the old and new walls are to resist the increased water pressure by their combined dead weight, actual contact between them was a necessity, and with that object in view the cross-section of the new slab was so designed that a plumb-bet line from its center of gravity intersects the foundation a short distance up-stream from the "heel" of the slab, causing the new wall to lean slightly against the old one, but to such a small extent as to leave the resultant of pressure, reservoir empty, within safe limits. It was further assumed that no bond should be permitted to be made between the well-seasoned masonry of the old wall and the fresh concrete of the new one. Hence provision was made to leave a well-defined plane of separation between them, so as to avoid the development of internal stresses which would arise during the settlement of the new work from the adhesion of the two walls to each other. As there is more or less seepage through the old wall it became necessary to drain the intermediate space between them with positive thoroughness. This problem was met by covering the entire face of the old wall with sheets of No. 28 corrugated steel, against which the new concrete was placed, the corrugations being placed vertically. By using sheets of muslin over the joints of the plates the thin cement was prevented from leaking into the space, and the result was the formation of parallel gutters at regular intervals from top to bottom. At frequent intervals 2-in. pipes lead from this space to a drainage tunnel built inside the new slab at the toe of the old dam, which has a branch outlet leading to the outside.

The various requirements of the problem being thus disposed of, and the gate valves of the three water pipes which pass through the dam being housed by forming a capacious chamber in the interior of the new wall, with every facility of access, the weight of the dam was computed to meet the new conditions of water pressure, assuming a maximum elevation of water in the lake at Elev. 240, flowing 5 ft. deep over the new spillway. In resisting overturning about its toe the composite dam is maintained on the foundation by its dead weight, and hence may be likened to a beam held fast at one end and subjected to a variable bending stress. The condition essential to its safety is homogeneity, eliminating undue stresses, particularly tensile strains on its up-stream face. In fact, the wall must combine sufficient dead weight and adequate rigidity, two qualities which do not necessarily coexist.

Instances are of record of the failure of dams of ample weight, which were ascribed to a crushing of the masonry at the toe, and whatever happened at the toe must have likewise been accompanied by a broken back. To meet these somewhat undefined, but rather positive stresses, steel reinforcement has been introduced in the slab of new concrete in the shape of heavy steel rails, placed wherever a safe tensile stress in the concrete failed to balance the bending moment at that point. Furthermore, when the old wall is considered solely as a gravity structure under its maximum load with high water at Elev. 220.5, unit pressures on the foundation become very unevenly distributed, reaching about 14 tons per sq. ft. at the toe, with a negative value at the heel, a condition due to the proximity of the toe and of the resultant of pressures. This unsatisfactory distribution has been corrected almost to uniformity by giving the two walls a common toe, 30 ft. below the old one. The aggregate unit pressure is still moderate, and becomes positive over the entire base. This has been brought about, and the connection of the old wall with the new toe made, by means of a grillage of 60-lb. track rails, and by transmitting to this grillage the pressure on the old wall through inclined struts made of similar rails. (See Fig. 5B and Fig. 6A.)

Reinforcement of the new wall against bending is made by layers of 30 and 40-lb. track rails, set parallel to the plane of contact, and as far as practicable from the neutral axis. (Figs. 5B and 6B.) These diminish in section from the base up until, at Elev. 196, their use becomes unnecessary. Diagonal strains are met by stirrups formed of a combination of wire cables and track rails, while distributing and temperature bars consist of horizontal courses of steel rope. All probable and possible strains have been carefully analyzed and provided for, and there are positive reasons to anticipate that the dam will be as stable and enduring under its new load as the old one has proven to be.

SPILLWAY.—This important adjunct has been entirely changed in position and character, and now consists of a channel cut in the rock and lined with concrete, alongside the reservoir from the old spillway for a distance of 200 ft. Between this channel and the lake is a parallel weir over which the water will pour in a direction at right angles to the channel. Stationary deflecting plates of steel placed below the weir at intervals of 5 ft. will change the direction of the flowing water some 30°, and then the water will strike a baffle of reinforced concrete which will still further change its direction to one parallel with the axis of the spillway.

As is shown by the general plan, Fig. 3, and the detailed plan and section, Fig. 7, the cross-section of the channel enlarges as it approaches the dam, and its floor has a grade of 3%, giving it a capacity equal to that of the weir, or a little more. The computed capacity of the weir is about 5,000 sec.-ft.

GENERAL.—In all the heavier walls large rock have been embedded in the concrete to the extent of 20 to 25% of the mass, increasing its specific gravity and reducing quantity of cement. The total volume of concrete in the new work is estimated at about 20,000 cu. yds. The total reinforcement required was as follows:

Steel track rails	296.48 tons
Corrugated bars	14.96 tons
Total	311.45 tons

The cement used is manufactured at the plant of the Riverside Portland Cement Co., under rigid specifications. Hydrated lime is used throughout the work to the extent of 5% of the cement in the body of the dam, and 10% in the spillway and superstructure. The work is being done by contract, Mr. Arthur S. Bent, of Los Angeles, being the contractor. Crushed rock is obtained within 1,000 ft. of the dam from a large crushing plant that has for years supplied San Diego with concrete material. Sand comes from the valley half a mile below the dam. It is clean, sharp, granitic sand, which originates in the higher mountains where granite is the prevailing ledge material.

CONCRETE-HANDLING TOWER.—The plant for handling the concrete and distributing it after mixing is one of the newer improvements of the West, originating in Los Angeles. All the concrete is shot out through pipes in various directions from a high central tower. The mechanism has developed a few defects, but most of these appear to have been overcome. It is chiefly of importance that the mix should be of the right consistency, neither too dry nor too "sloppy" to run properly without separation of the aggregates. From the view (Fig. 8) it is clear to what distance the concrete is delivered. It is a labor saver, and increases capacity. This plant has made and deposited approximately 300 cu. yds. in nine hours.

The entire cost of the extension will be somewhat over $180,000, including an earth embankment or dike in a gap on the rim of the reservoir. This dike has a maximum height of 28 ft., extending 8 ft. above spillway level. It is 1,060 ft. in length, 8 ft. wide on the crest, and contains 12,000 cu. yds. of earth. The riprap of the water face of the dike consists of heavy crude oil, or liquid asphaltum, harrowed and rolled into the slope.

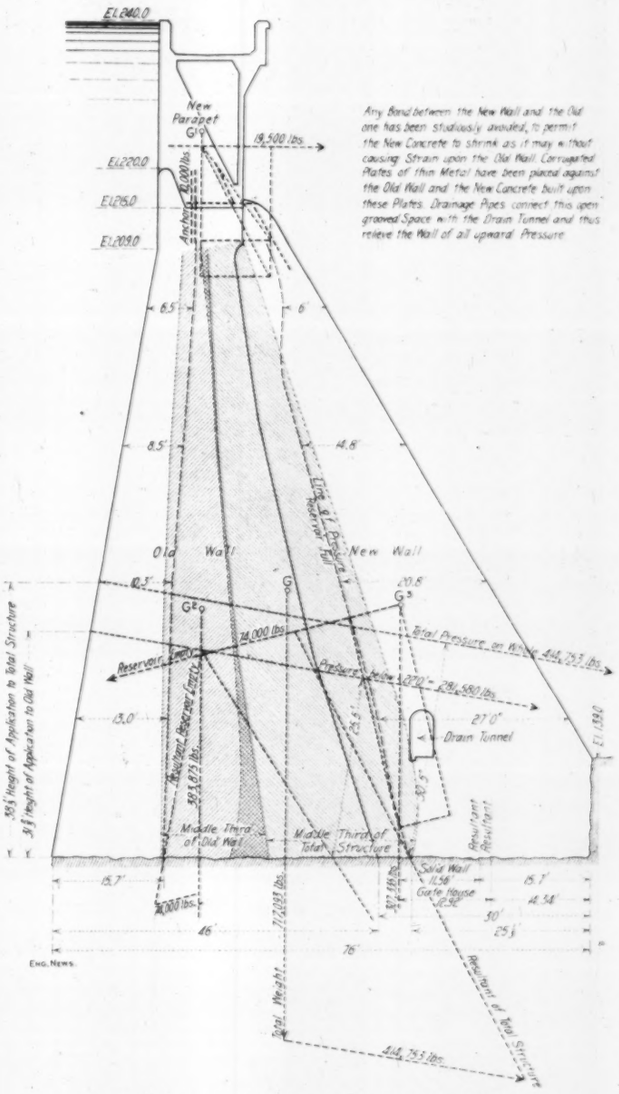


FIG. 4. DIAGRAM OF FORCES OF MAXIMUM SECTION OF EXTENDED SWEETWATER DAM.

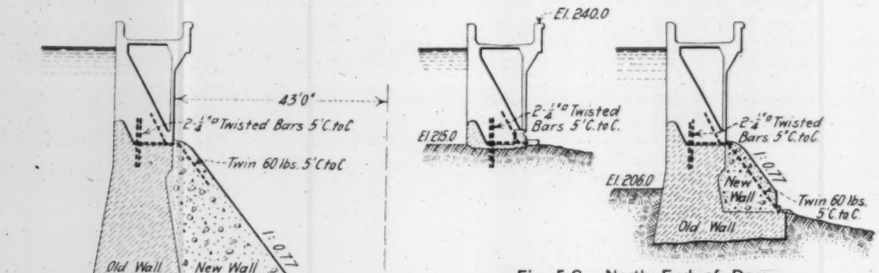
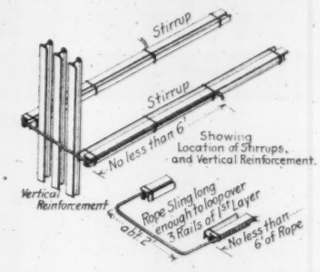


Fig. 5 C. North End of Dam, Showing Concrete Slab Without Reinforcement.


Stirrup
Stirrup
No less than 6'
Showing Location of Stirrups, and Vertical Reinforcement.
Vertical Reinforcement
Rope Sling long enough to lap over Rails of 1st Layer
No less than 6" of Rope

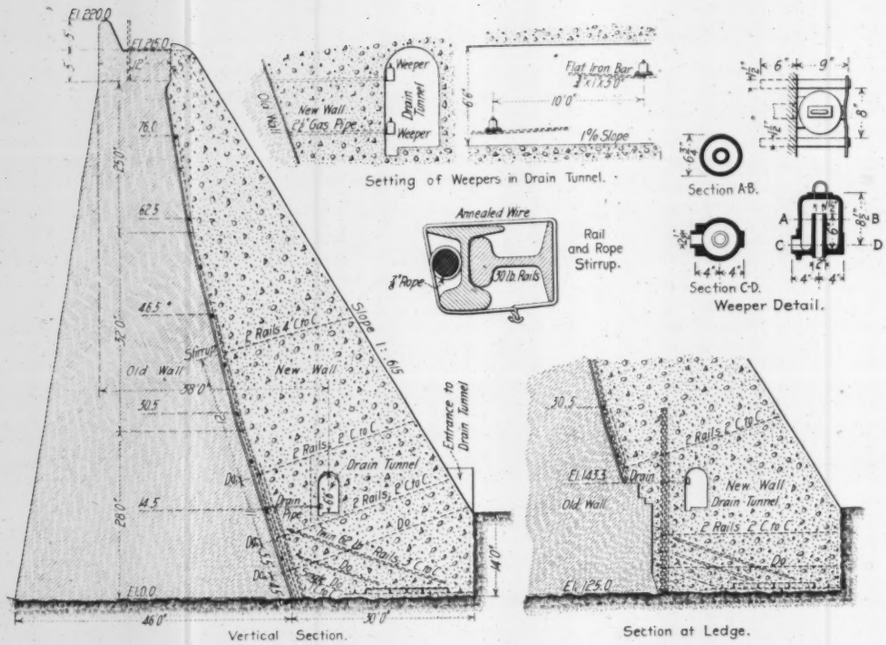


Fig. 5 B. Reinforced-Concrete Slab Added to Down-Stream Face, With Details of Steel-Rail Reinforcement and Drainage Tunnel.

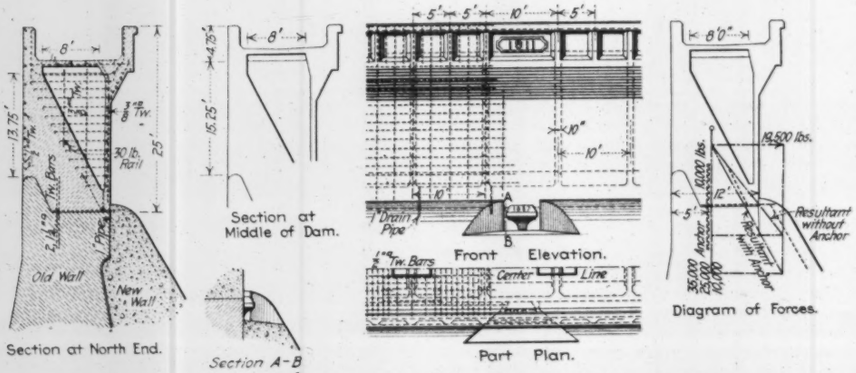


Fig. 5 A. New Parapet and Reinforcement, Including Diagram of Forces.

FIGS. 5A, 5B AND 5C. SECTIONAL AND OTHER DETAILS OF EXTENSION OF SWEETWATER DAM, REINFORCED-CONCRETE WALL, PARAPET, AND DRAINAGE TUNNEL.

The Waterproofing of Masonry.*

As to the cost of waterproofing, the conditions are so widely different that hardly any two of the reports received cover the same conditions. Under these circumstances, an average cost for any one type of waterproofing would be probably far from the true cost. The masonry structures usually waterproofed are: (1) the floors of solid-floor bridges and arches over city streets, to prevent the leakage of ballast water; (2) roofs and walls of subways, to prevent the leakage of rain water; (3) basement and building walls, concrete roofs of buildings and retaining walls, to prevent the leakage of rain or ground water; (4) reservoir and tank walls, to prevent loss by leakage.

The subject of waterproofing may be considered from two points of view: (1) the imperviousness of various substances, (2) the methods of treating certain masonry structures so as to prevent the leakage of water through them. The first is a laboratory problem. The second is a practical problem and is the one considered by the committee. This point of view involves the element of suitability to use and also the personal equation of the person making the examination. A reservoir wall may be permitted to leak a few gallons daily; a bridge floor must not allow water to drip; in some situations a stain or discoloration would be objectionable and must not be allowed. Different observers might report compliance with any of these conditions as "perfectly satisfactory." In comparing different methods of waterproofing this element must be eliminated.

The systems mentioned in the returns have been grouped in the accompanying table in four general classes, according to the method of waterproofing employed. Class 1 includes all those processes by which the masonry is covered with a thick coating of more or less impervious material, generally applied in several layers and generally including tarred felt or similar fabric or burlap.

The waterproofing materials used are coal tar pitch, asphalt or bituminous products of petroleum. The felt is laid in overlapping layers with a coating of the waterproofing compound between the layers. The whole is then protected from abrasion by a layer of sand, mortar or brick. Sometimes the masonry is first swabbed with the compound, causing the felt to adhere. It has been supposed that where the fabric is bonded to the masonry it cracks from expansion and contraction more readily than where it is not so bonded. The reports do not indicate whether or not this is true. Whatever material is used for the exterior covering must have considerable elasticity and strength to resist the effects of continual expansion and contraction of the masonry. Burlap has been used in some instances and some felts have been prepared with a canvas back.

Under Class 2 have been grouped all examples of materials mixed with concrete. This includes liquids or powders sold under various trade names. The committee is not advised as to the naturo of these compounds, and from the few examples reported no conclusion can be drawn.

Class 3 includes all exterior coatings of the nature of washes or paints. Some of these coatings are heavy, but differ from Class 1 in thickness and in being used without fabric. Class 4 includes those examples in which no waterproofing material was used. The number reported is too few to warrant any conclusion.

An analysis of the replies indicates the following:

(1) No method of waterproofing has proved entirely satisfactory.

(2) Some cases are reported in each class showing no leaks.

(3) The difference in efficiency between the various classes does not appear to be great. It does not appear to what extent success is due to the quality of masonry.

(4) Failures are due to faulty details, poor workmanship, poor materials and the formation of cracks in the masonry.

(5) To secure dry work, it is necessary that details should be carefully designed; this includes the details of the masonry as well as of the waterproofing. The materials must be carefully placed by skilled workmen. The supervision must be constant and efficient. Shrinkage and temperature cracks should be prevented by reinforcement.

(6) Concrete masonry designed and placed as above indicated, with properly designed temperature and shrinkage reinforcement, may be made waterproof without the addition of special waterproofing materials.

RESULTS OF WATERPROOFING MASONRY BY DIFFERENT METHODS.

	No leaks.	Leaks slightly.	Leaks badly.	Total.
1. Exterior envelopes.....	31	16	44	91
2. Substance mixed with concrete	5	1	2	8
3. Exterior coatings.....	6	9	27	42
4. No waterproofing.....	1	3	..	4
Total.....	43	29	73	145

*Abstract of a portion of the report of the Committee on Masonry, presented at the annual meeting of the American Railway Engineering and Maintenance-of-Way Association, at Chicago, March 21 to 23, 1911. The report includes descriptions of some 50 specific cases of waterproofing structures of different kinds.

Fig. 6a. Placing Foundation Reinforcement, Aug. 1, 1910.

Fig. 6b. Vertical Reinforcement and Forms for Drainage Tunnel, Oct. 1, 1910.

FIGS. 6A AND B. VIEWS SHOWING STEEL RAIL REINFORCEMENT OF CONCRETE SLAB ADDED TO THE FACE OF THE SWEETWATER DAM.

A TELEPHONE TRAIN-CONTROL SYSTEM is being installed by the Pennsylvania R. R. at its Philadelphia terminal. This is said to be the first case of a complete dispatching system within the limits of a terminal. This system is unique, being in some measure a telephone train line having intercommunicating features only between certain points. Dispatchers' offices are located at "S" tower, which is a telegraph office at Thirty-Second St., and at "A" tower, at Seventeenth St. At the latter point three calling equipments are provided, which enables any one of the three operators to call any station, while at "S" but one calling equipment is provided.

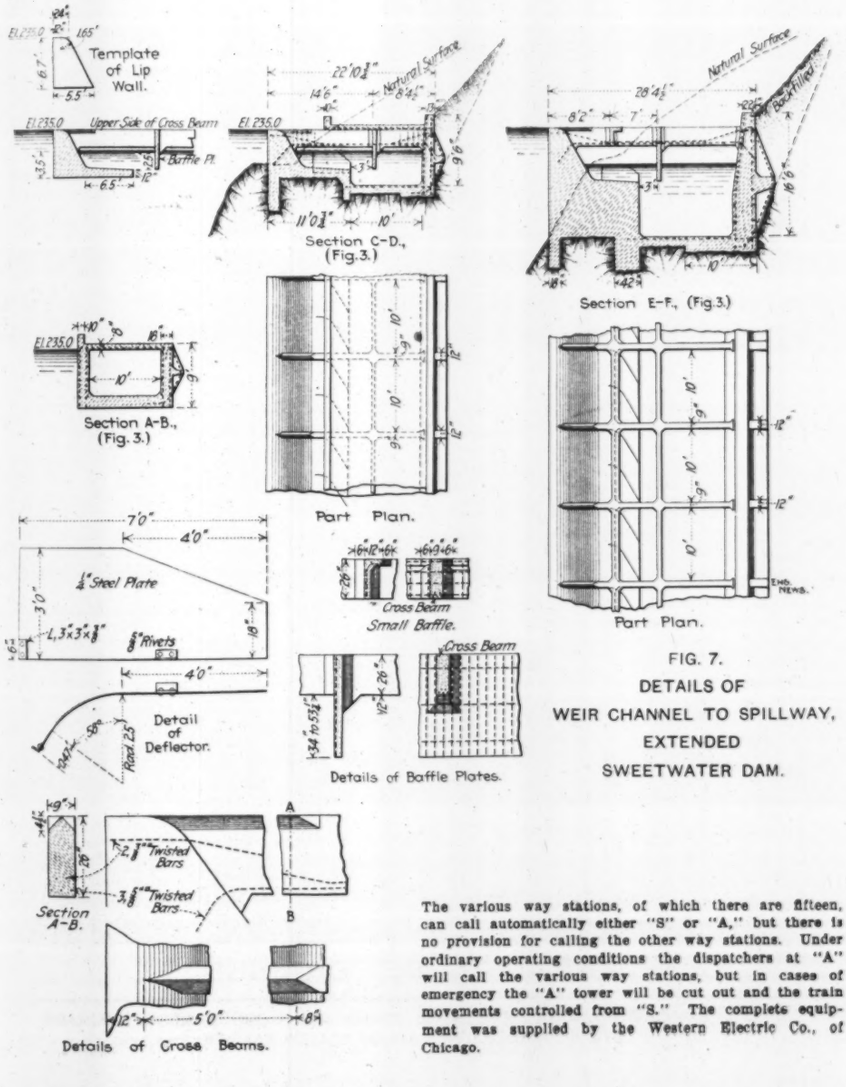


FIG. 7. DETAILS OF WEIR CHANNEL TO SPILLWAY, EXTENDED SWEETWATER DAM.

The various way stations, of which there are fifteen, can call automatically either "S" or "A," but there is no provision for calling the other way stations. Under ordinary operating conditions the dispatchers at "A" will call the various way stations, but in cases of emergency the "A" tower will be cut out and the train movements controlled from "S." The complete equipment was supplied by the Western Electric Co., of Chicago.

The Milwaukee Bureau of Economy and Efficiency.

By P. H. MYERS.*

One of the most interesting investigations into the economy and efficiency of city accounting methods being conducted in this country at the present time is to be found in Milwaukee.

The investigation in that municipality which is being conducted by the Bureau of Economy and Efficiency, is distinctive principally because it was inaugurated by the administration, Milwaukee thus becoming the first city in the United States to realize that its accounting methods were defective and to be willing to ask experts to step in and make the necessary revision. The investigation has the full cooperation and assistance of all departments, whereas, the work in other cities has been started by private associations and organizations, usually against the wishes of the city officials.

The Milwaukee work has the further advantage of the very thorough cooperation of The University of Wisconsin, the State Tax Commission, and the State Railroad Commission, whose experts lend their assistance at a cost much less than if a new organization had had to be built up and experts called from the same line of work in other cities.

The Milwaukee Bureau of Economy and Efficiency is an outgrowth of a proposition on the part of the city officials to conduct a survey similar to the Pittsburg Survey, but built upon much broader lines. They were fortunate in securing the services as director of Prof. John R. Commons, of the University of Wisconsin, who did important work in the Pittsburg Survey, and of Dr. Benjamin M. Rastall, also of the University, who has had broad experience in organization work for private business enterprises, as associate director.

The Milwaukee Bureau is conducting surveys along several lines in addition to the investigation into the accounting methods and business procedure of the municipality. The other subjects of the survey include investigations into (a) cost of living; (b) legal aid for the poor; (c) hospitals and dispensaries; (d) unemployment; (e) poor relief; (f) immigrants; (g) industrial hygiene; (h) boys; (i) housing and sanitation; (j) house registration of tuberculosis patients; and (k) the condition of working women, girls and children.

While investigations along all lines of the survey are being rapidly pursued, it is especially the work being done in regard to a revision of the city's accounting methods and business procedure that will be considered in this article.

Detailed studies of the procedure of every department, following the completion of a digest for each department of the legal requirements estab-

*Of the staff of the Bureau of Economy and Efficiency, City Hall, Milwaukee, Wis.

lished by the city charter, ordinances, and State law, and charts of the organization of the departments, are planned before reorganization is in any way attempted. With this detailed study as a basis, revision can proceed along coordinate lines.

A general plan of procedure has been outlined by Dr. Rastall, who has direct supervision of this division of the survey. Legal digests have been completed by Mr. C. R. Fletcher and assistants, under the direction of Prof. W. U. Moore, College of Law, The University of Wisconsin; and charts of the organization of each department, showing the relation of each employee to the head, with digests of the duties performed by them, have been completed by Mr. John E. Treleven.

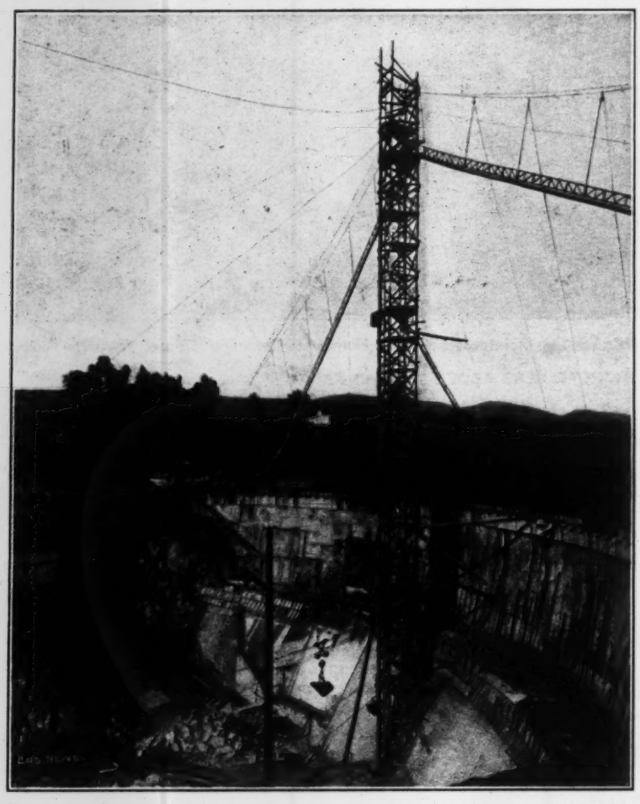


FIG. 8. VIEW OF CONCRETE ELEVATING TOWER AND DISTRIBUTING ARMS, USED IN EXTENDING THE SWEETWATER DAM.

Detailed study of the procedure in vogue in the various departments has been begun by the staff of experts and will be continued until all departments have been studied. The staff which is being carefully and gradually built up consists at present of M. Cerf, P. H. Myers, J. E. Treleven, F. H. Elwell, I. A. Hankey, and A. W. Spaulding.

Even though the study of the procedure in the various departments has been carried on only a short time, changes already in mind to be effected in the method of collection and incineration of garbage and ashes are expected to save the city more money each year than the entire cost of the survey.

Mr. Cerf, who was detailed to this work, made first a study of garbage and ash collection, while Dean L. E. Reber, Extension Division of The University of Wisconsin, a consulting engineer, and Prof. E. B. Norris, College of Engineering, University Extension Division, made a study of incineration at the municipal incinerator, from an engineering standpoint, and will soon report on the utilization of the clinker and the steam waste. The problem in Milwaukee is the disposal of garbage. Ash removal is not considered a problem, as there are many valleys in the city into which ashes and rubbish may be dumped for years to come. An incinerator for the disposal of garbage was constructed in June, 1910 [see Eng. News, July 21, 1910], and the incineration under Superintendent S. A. Greeley is perfectly accomplished. For the burning of the garbage, however, it is necessary to add ashes to the mixture, as it is the unburned coal in the ashes, largely, that furnishes the heat. The city furnishes about 2,000 tons of garbage monthly to the incinerator during the winter, so that only enough ash to make the proper mixture for burning need be carried to the incinerator. All the city's ash, therefore, except that of five wards, is hauled to the dumps.

From a set of forms devised by Mr. Cerf, data on the deliveries of all classes of refuse to the incinerator were obtained which showed that the quantity being delivered was in excess of the capacity of two furnace units and less than the capacity of three, thus making the cost of incineration per ton appear high. By securing regulation of the deliveries of ashes and rubbish so that only an amount sufficient to procure proper combustion for two furnace units will be delivered to the incinerator, a saving of about $600 per month in the cost of incineration alone may be effected.

From the fact that the collection and disposal of street sweepings, removal of snow, flushing and sprinkling of streets, are very closely related, the study of the collection of ashes and garbage is being made to include the study of these questions. It is believed that the working force necessary for the handling of the city waste can be best organized if all these elements are considered as one line of activity.

One of the greatest elements for economy is expected to come from securing the cooperation on the part of the householder in the placing of the ashes so that they are readily accessible to the collectors. At present the collectors are compelled to go into the basements and bring out the ashes, which naturally means loss of time on the part of those gathering, as well as a very considerable loss of time for each team.

As a result of a recent trip east made by Dr. Rastall, a thorough system of cooperation between the Milwaukee Bureau and other offices of experts making similar investigations in city accounting methods, has been arranged. All of the plans and working papers of both the Milwaukee and Chicago Bureaus will be exchanged. Boston, New York, Washington and Philadelphia are much interested in the Milwaukee work and will cooperate wherever possible.

Reclamation Drainage in South Dakota.

By A. B. McDANIEL.*

The State of South Dakota is one of the most interesting districts in the West on account of its varied topography, climate and resources. A few years ago, when this country was but sparsely settled, the low land was generally unoccupied and only the higher and dryer lands were settled and improved, but now as the wonderful fertility of the soil in the lower lands is becoming known to the farmers in the neighboring states a great influx of people is setting in. With this increase in demand for land, and with the diminishing supply of desirable property, the time has come when the low, wet lands must be reclaimed and utilized.

The Missouri River, in its rambling course southward through the central portion of the state, divides it into two nearly equal sections of peculiar and varied character. The eastern section is quite flat, although a portion of the eastern district marked off by the irregular course of the Sioux River is broken up by the great drainage basins of the James and Vermillion rivers. To the west of the Missouri River the country becomes more rolling, with level plains between the drainage basins of the White, Cheyenne, Moreau and Grand rivers. These valleys run in a general easterly direction as the rivers flow from the higher elevation of the Black Hills at the western boundary of the state.

The eastern section of the state is that in which the writer is most interested at the present time. The present surface was molded much as it is today during the glacial epoch, and these level areas found here are dotted with a great variety of basins of various shapes and sizes, from the smallest pot-holes to the large lakes of the central and northeastern counties. These basins and lakes are generally connected by natural dry channels or "draws" which should furnish an outlet into some valley or greater basin. In this way a drainage system is found possible which is generally

*Professor of Civil Engineering, College of Engineering, University of South Dakota, Vermillion, S. D.

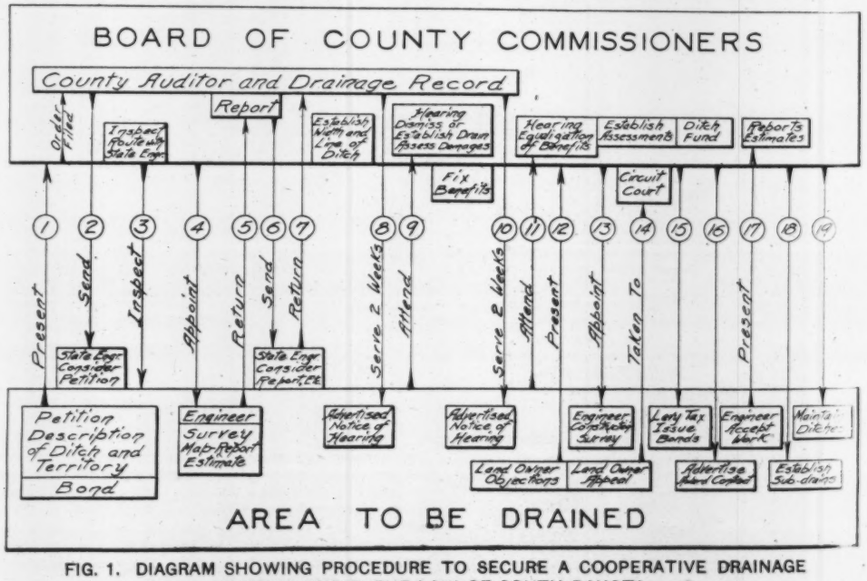


FIG. 1. DIAGRAM SHOWING PROCEDURE TO SECURE A COOPERATIVE DRAINAGE SYSTEM UNDER THE LAW OF SOUTH DAKOTA.

complete from the small slough to the great channel of the Missouri. There are some cases, however, where basins are land-locked and without direct outlet. An investigation usually shows that a channel may be cut through the lowest section of the high land to provide a convenient and suitable outlet to some natural water course.

In early spring, the season of melting snows is usually followed by heavy and continuous rainfall extending into early summer. The numerous basins are rapidly filled with water, and on account of the general flatness of the land the run-off is slow. This sluggishness along the drainage channels has caused a continuous and rapid deposition of silt and debris which has tended to clog the natural outlets. In this way the basins have been gradually filled in by silting up of the banks. Natural channels, connecting the basins, are also filled up and at intervals small natural ridges or dams are formed. In the case of the large flowing streams the periodic Spring overflow has caused the deposition of material along the banks, thus gradually raising them above the neighboring land. The overflow waters are prevented from returning to the channels so that the water lies on the ground until it is removed by evaporation or seepage. In these ways, during the past ages, great areas of wet, swampy, land have been formed in this state, until now they amount to about 450,000 acres.

The great masses of soil which have been brought down from the north, and the amounts of silt and vegetable matter which have been deposited during the periodic overflows, have formed a surface soil principally composed of rich loam. Throughout this section of the state the soil is remarkably rich and fertile in character, and the wet and swampy lands are of the greatest fertility and richness. Their uselessness for agriculture lies solely in their excess of moisture. During the last decade, the annual rainfall has gradually increased and a large proportion of the increase has been during the spring-flood seasons.

Fig. 3. Looking East From Above Highway Bridge.

Fig. 4. Looking Northwest from Midway Down the Concrete-Lined Channel.

FIGS. 3 AND 4. OUTLET SECTION OF MINNEHAHA COUNTY DITCH NO. 1.

This has precipitated great volumes of water within comparatively short periods of time, so that even the higher sections of the lower lands, which had been cultivated by the early settlers, have been rendered uncertain producers of crops.

With the spread of knowledge of scientific farming, the farmers have found that these swamp lands may be readily and permanently reclaimed and may become a part of the state resources. In the northern part of the state, Day, Brown and Marshall counties have large numbers of these flat basins which would naturally drain into the James River a few miles south of Aberdeen. The land owners in the western section of Marshall and Day counties have already begun drainage projects in which it is planned to redeem about 60,000 acres of land which is now for the most part submerged. This single project will include about 60 miles of open ditch and the straightening and enlargement of the north fork of Mud Creek, a tributary of the James River. In going farther south, these basins are found to continue down along the eastern boundary of Clark county. Here are a number of very large flat marshes which are apparently land-locked and without natural outlet. One of the best known of these is the "Ancient Lake Bed," a few miles west of Vienna. Another, the so-called "Dry Lake," contains about 5,500 acres of submerged land and here a complete drainage system is about to be constructed to reclaim this and adjacent areas. To secure an outlet it will be necessary to construct a concrete conduit about 6 ft. in diameter and 2 miles long. This will empty into a natural run which will be straightened and enlarged so as to carry the water to a final outlet in the James River Valley. The cost of this system will probably amount to $30 per acre of land benefited.

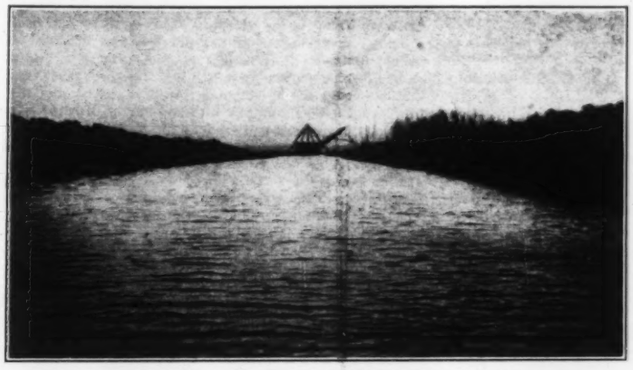


FIG. 2. TYPICAL SECTION OF CLAY CREEK DITCH, SOUTH DAKOTA.

Still further south, in Kingsbury county, several great and partially land-locked marshes are found grouped about the city of Lake Preston. It is now proposed to drain the largest of these lakes —Lake Preston, Lake Thompson and Lake Whitewood. This drainage will be in a general westerly direction into the basin of Lake Henry, thus furnishing the latter with water enough to permanently fill its deep basin. In the southeastern part of Kingsbury county several drainage projects have been designed, and one very interesting one is now under construction. This project consists of the drainage of a great number of small basins and sloughs for the reclamation of about 1,000 acres of land now submerged. There will be here 48 miles of open ditches and five miles of tile drains varying in size from 8 to 20 ins. in diameter.

In the eastern part of the low-lands and near the city of Sioux Falls, during the past two years much work has been done in reclaiming land in the valley of the Big Sioux River. Two ditches have been constructed having a total length of seven miles and reclaiming 21,080 acres. The cost of this ditching has been about $15 per acre of land benefited. Two unique features are seen in connection with the construction of these ditches here. One is the building of a highway upon the top of one of the spoil banks. This furnishes a road high above the wet land of the valley. The second feature of interest is the construction of the outlet of the main ditch from the top of the valley near the State Penitentiary to the river below. This outlet is an open ditch lined with a thick layer of concrete and having an average fall of about 13%. To stop cutting away of the adjacent banks it has been necessary to build a large masonry apron at the foot of the fall.

Smaller areas of swamp land are being reclaimed by the owners in the southern tiers of counties. It is not until the Missouri River is approached, however, that large areas of wet low lands are found. In Clay and Yankton counties, along the northern bank, there are about 60,000 acres which require drainage to become useful for agriculture. On Jan. 12, 1910, the Clay Creek drainage ditch was completed. This directly drains 33,000 acres of bottom land and indirectly 35,000 acres of bench lands. The ditch is nearly 17 miles in length and required the removal of 1,250,000 cu. yds. of earth at a cost of about $120,000. With the construction of laterals into the flat lands, the owners of the territory are beginning the installation of tile drain systems so that in a few years there will be a complete reclamation. Another ditch, 20 miles long, with a complete system of laterals, has been designed for 40,000 acres south of the land drained by the Clay Creek ditch, and the construction of this system will probably begin early in 1912.

Plans have been completed for what will eventually be the largest project in the state. It contemplates now the drainage of about 7,000 acres of valley land along the Vermillion River for about 16 miles north of the city of Vermillion. This ditch will be about 11 miles long. The construction will require the excavation of about 2,000,000 cu. yds. of earth and the cost will be about $30 per acre of land benefited.

A farm or small area, owned by one person, can be drained independently and at the discretion of the owner. However, if there are a number of such farms, which are adjacent to each other and require drainage into one natural outlet, then cooperation is necessary to secure the benefit for each and all. Several years ago, it was found that, when a large number of land owners were obliged to cooperate, there must be some legal method of procedure, by which a definite and satisfactory result could be reached under due procedure of law. Hence in 1907, the Legislature passed the Original Drainage Law. This law was based upon that of the state of Iowa, and it has proved to be a very useful and efficient method of carrying out large drainage projects. The Legislature of 1909 amended the original law by placing the jurisdiction of the drainage work under the State Engineer, thus greatly increased the standard of construction.

The following schedule and the accompanying diagram (Fig. 1) show the series of steps which are necessary to be taken in order to secure the construction of a drainage project under the State law:

(1) A petition for the proposed drain, signed by one or more land owners, is filed with the County Auditor. (2) The Board of County Commissioners considers the petition, goes over the proposed route with the State Engineer and, if deemed advisable by the latter, orders an examination and survey to be taken by a competent engineer. (3) The engineer selected makes an examination and survey and submits plans to the Board of County Commissioners. (4) The Board of County Commissioners considers this engineer's report, together with a supplementary report thereon by the State Engineer. The County Commissioners advertise for a public hearing. (5) A public hearing is held, at which the Board of County Commissioners considers the petitions for, or the objections to, the proposed project as outlined in the engineer's report and either grants or rejects the petition, thus establishing or rejecting the drain. After the petition is granted, the damages to be paid for land taken for the construction of the ditch are then determined. At this time also, an engineer is employed to make the final plans, specifications and survey for the proposed drainage system. (6) The Board of County Commissioners meets and equalizes the benefits to each land owner. The County Auditor advertises

for a public hearing. (7) A public hearing is held at which the Board of County Commissioners hears the objections of assessed land owners. A portion of the estimated cost of the proposed ditch is then equally assessed against each owner, whose land is benefited and also against the townships for the benefit which the highways will derive. Steps are taken to determine a satisfactory method of levying the cost, either by issuing ditch warrants from the ditch fund or by a bond issue. The County Auditor advertises for bids for the construction of the drainage system. (8) A public meeting of the Board of County Commissioners is held and bids for the construction of the drainage system are received, opened and considered. The contract is usually awarded to the lowest responsible bidder. (9) The construction of the ditch and the final acceptance by the Board of County Commissioners is upon the recommendation of its Engineer. (10) Laterals are constructed if necessary to furnish complete drainage for the district. (11) Maintenance of the constructed work is organized.

It is certainly just as feasible and practicable to drain the 450,000 acres of wet land in South Dakota, as it is to construct good buildings or good roads, or to make any other necessary improvements for the development of a community.

The problems of drainage, in this state, are comparatively few in number and simple in character. Most of the areas needing drainage lie at a higher elevation than the mean low water level of some neighboring natural water course which will furnish suitable outlet. The natural water courses in this state, on account of the general flatness of the surface over which they flow, must be straightened, widened, or deepened in order to furnish satisfactory channels. In some cases it may be necessary to construct dikes or levees along the low sections of the banks of these channels, to prevent inundation of neighboring lands during the flood season.

The most important consideration to any land owner, is the cost of the proposed work. The farmer who plans to drain his marshes desires to know whether the benefits fits will compensate him for the expense. In this state during the last few years the market value of low swampy land has varied from $10 to $40 with perhaps an average value of $25 per acre. The drainage of such land has cost from $10 to $40 per acre, depending upon the thoroughness and completeness of the drainage system installed. For open ditches alone, the average cost per acre for the construction of the drainage system has been about $18. The market price of the land, after the drainage system has proved its usefulness by one or two years of service, has risen to about $75 per acre, and in some cases has approached $100. If there are 450,000 acres of swamp lands which can be reclaimed, a simple scheme of drainage will increase the resources of the state by a net sum of $9,000,000. Each land owner benefited has at once increased his capital by about $20 per acre, net. The increase thus shown will be immediate, while past experience in neighboring states has shown that future and larger increases in the value of the land will later follow. The reclaimed land possesses this greater value, of course, through increased crop production.

Fig. 1. Form of Cylinder and Valve for Hydraulic-Pressure Tests.

(Diam. of joint, 1¼ ins.; bore, ⅝-in.; wall thickness, ⅜-in. The cylinder shown is one of the gun-metal cylinders, of the preliminary tests, after it had split from end to end at a pressure of 19½ long tons per sq. in.)

SOAPY WATER FOR SPRAYING COAL DUST in mines was suggested at a recent meeting of the North of England branch of the Association of Mining Electrical Engineers by Prof. Thornton, of Armstrong College, Newcastle-on-Tyne. It was claimed that a much smaller proportion of soap solution than of clear water would suffice to wet the dust. Moreover, the dust wet with soap solution, after drying, was left in a sticky condition which made it less likely to be picked up by air currents than was the case with water-treated dust. Prof. Thornton has not yet tried out his plan on a practical scale but has demonstrated the effectiveness of the soap solution by laboratory experiments.

Hydraulic Pressure Tests of Aluminum-Bronze Cylinders.[1]

By H. C. H. CARPENTER[2] and C. A. EDWARDS.[3]

This paper contains an account of an investigation undertaken by the authors three years ago, with the encouragement and financial support of the Council of the Institution of Mechanical Engineers.

The object of the investigation was the production of castings of non-ferrous alloys capable of withstanding high pressures, whether hydraulic, steam or gaseous. The authors were led to undertake this work, in the first instance, owing to the difficulty experienced by Mr. Cook, the instrument maker to the University of Manchester, in obtaining such castings for high-pressure hydraulic pumps. The particular difficulty was not that these castings could not be obtained from the makers, but that they could not be obtained with any degree of regularity; for example, a sound casting might be followed by half a dozen faulty ones before another sound casting was delivered. This fact indicated that the conditions of production were not fully known. An exception must be made in the case of one firm, whose hydraulic castings were almost invariably sound when first cast. These, however, showed so much tendency to "crystalize" that after a year or so they were useless owing to their having become leaky.

Fig. 2. Chill Mold for Casting Test Cylinders.

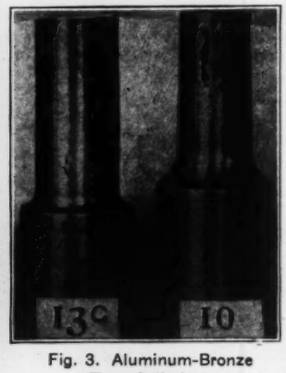


Fig. 3. Aluminum-Bronze Test Cylinders.

(No. 13c, 11% aluminum; wall thickness reduced to ⅜-in.; burst at pressure of 18 tons per sq. in. No. 10, 9% aluminum; wall thickness reduced to ¼-in.; remained unbroken after sustaining pressure of 19 tons per sq. in.)

During the course of their work the authors were informed of numerous cases in which difficulties were experienced in obtaining hydraulic castings used for other purposes than high-pressure pumps. They venture to hope, therefore, that the results about to be recorded may be of service to the makers of high-pressure castings in general.

Method of Testing.

The entire work has been done at the University of Manchester. The alloys were cast in the metallurgical department. They were melted in crucibles in an oil-injector furnace, which permitted the handling of 500-lb. charges. The castings were then machined, and if they appeared to be clean and sound, the valve was fitted into them. In the earlier experiments the valve was made of the same alloy as the casting. Inconvenience, however, arose from the fact that sometimes the valve failed before the casting. Accordingly a mild-steel valve was used in all the subsequent tests. This valve was coned at one end, and in making the joint it was pulled down so as to "bite" into a flat surface machined in the casting. The arrangement is shown in Fig. 1.

The casting was first tested on a pump, made of a special bronze, with which the pressure was ... to 4 tons. If the casting held this without the ... of leakage for 24 hours, it was considered to ha... the preliminary test. It was then tested on a ... sure hydraulic pump[4] designed by Prof. J. E. ... F. R. S., which permitted of the pressure be... to 20 tons. In carrying out a test, the pressure ... raised to about 7 tons by working the ram. ... pressures were then obtained by operating th... When the pressure exceeds 15 tons the labor is ... able. A special feature of the pump is the ar... of the valves and an auxiliary valve-block, whi... the full pressure to be maintained continuous... length of time.

THE CASTING OF CYLINDERS.—The autho... the simplest case possible the casting of a cy... chill mold. By doing this they reduced to a min... chance of encountering difficulties caused by ... and the pattern, and were able to concentr... selection of a suitable alloy, and the workin... the conditions of casting it. The mold specially ... for the purpose is shown in Fig. 2. It was ... grey cast-iron. The part occupied by the metal ... white, and shows the gate terminating in a ... which leads to the casting proper. The latter ... mounted by a riser. The cylinder was 6 ins. by ... ins. After cutting off the gate and riser, it was ... to 5¾ ins. by 2¼ ins., and was then bored in ... manner shown in Fig. 1, the bore and thickness of ... being ¾-in.

The use of a chill mold not only reduces to a ... the liability to blow-holes, but also to pinholes ... ...ciness. Rapid cooling is one of the chief ... to the escape of gas. By causing molecular contraction ... prevents the inclusion of gas bubbles between adjacent ... crystals and assists in expelling them through the ... liquid interior. Thence they rise through the central portions of the ingot, and are enabled to escape into the air.

Preliminary Tests with Gun-Metal.

At the outset, experiments were made with a pure gun-metal containing only copper and tin, in the proportions of 85 to 15. Owing to the inappreciable volatility of these metals under the conditions of melting and casting, it was easy to make any alloy of this composition, and to repeat it as often as was required. In this respect it presented advantages over the complex gun-metals and still more complex manganese-bronzes. Metals of the highest commercial purity were used—electrolytic copper and "Straits" tin, containing 99.98% of the respective metals. The copper was melted under wood charcoal in a covered crucible. After the addition of tin, sufficient phosphorus, in the form of a copper phosphide, containing about 15% of phosphorus, was added so as to remove oxygen and leave not more than 0.1% of phosphorus in the cast alloy. After stirring well and skimming, the metal was poured. It was, of course, cast from the bottom.

Under these conditions, the authors were able repeatedly to produce castings which were perfectly sound and after machining withstood pressures of, on an average, 18 tons[5] before they burst. Previous to fracture there were no signs of leaking. So far as chill casts are concerned, therefore, this pure gun-metal alloy when freshly cast gave quite satisfactory results, though it showed itself to be a somewhat brittle material.

The next step consisted in casting the same cylinders in sand molds. These were cast from the bottom and were supplied with a large riser. Both green and dry sands were used. The castings made in this way were not very satisfactory. Some of them held no pressure at all; others could be taken up to 5-7 tons pressure, but never above this. Attempts were made to cool the castings quickly by embedding blocks of metal in the sand, that is, having the surface of the mold made of sand backed up by metal, and thus producing a mold intermediate between chill and sand, but the castings were no better.

The authors are inclined to attribute their difficulties in obtaining sound castings of this alloy in sand to the consequences of the segregation of tin-rich areas, and the trapping of gas bubbles between the crystals during the large freezing interval (about 150° C.) of the alloy, which is only slowly passed through. Experiments in this direction were not pushed further because the authors learned that gun-metals of this composition deteriorate with lapse of time. Quite frequently an initially sound casting becomes leaky after a year or so. The nature of the change is not understood, but it is not very surprising that a change does take place. Possibly it may be accounted for by the fact that the constituents of these alloys, which are obtained in commercial castings, are in a metastable condition, and that they undergo a slow change even at the ordinary temperature into the stable form.

Tests of Aluminum-Bronze Cylinders.

Experiments with the aluminum-bronzes were next taken up. From their experience gained in preparing th...

[1] Abstract from paper read before the (British) Institution of Mechanical Engineers, Dec. 16, 1910.

[2] Professor of Metallurgy, Victoria University, Manchester, England.

[3] Research Fellow and Demonstrator, Victoria University.

[4] A full account of this is given in "Engineering" (London), Vol. 84, pp. 97-98.

[5] The long ton, 2,240 lbs., is used throughout this paper.—Ed.

"Eighth Alloys Research Report"* to this Institution, the authors considered that certain of these might prove to be suitable materials.

CHILL MOLD CASTINGS.—The first aluminum-bronzes made were cast in the chill mold already described. In order to reduce the cost of the experiments, the authors' practice throughout their investigations has usually been to make 6 casts at a time of any given alloy, thus enabling them to be machined together. The first mixture contained 91% of copper and the remainder aluminum. (The purity of the latter was 99.53%.) They were prepared by melting the copper in a covered crucible and adding the aluminum to the fluid copper. A considerable amount of dross formed under these conditions. It was removed as far as possible by stirring and skimming. The temperature of the melt was taken in the crucible by a thermo-junction and direct-reading pyrometer. Each mixture was poured at 1,125° C., which is about 80° above the freezing point.

With one exception, the castings thus obtained were quite satisfactory. Some of them contained signs of dross, but this appeared to be confined to the surface, and did not affect the soundness of the material. After machining they were tested up to 12-13 tons. At about this pressure the casting stretched slightly and water was forced through the valve-joint. It was possible to raise the pressure to 14-15 tons by tightening up the joint. After this the material stretched again, and the process had to be repeated. At 18 tons none of the four sound castings had fractured. The tests were stopped here. This 9% aluminum-bronze thus proved itself capable of holding the same high pressures as the 15% gun-metal, with the difference that it showed greater ductility.

Fig. 4. As Cast, Complete with Gate and Riser.

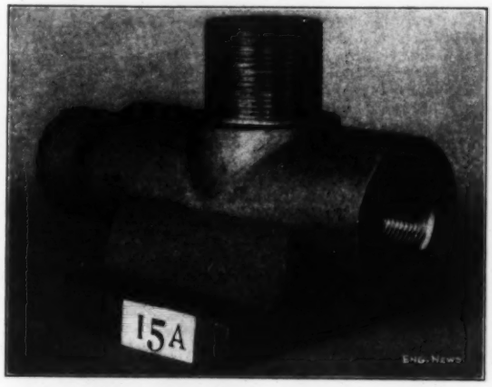


Fig. 5. Machined for Testing.

FIGS. 4 AND 5. ALUMINUM-BRONZE VALVE BLOCK FOR PRESSURE TESTS.

GREEN-SAND CASTINGS.—Six casts of the same composition were then made in green-sand molds. The metal was poured from the bottom and a large riser used. Three castings did not even pass the preliminary test. The remaining three appeared satisfactory and were then tested under higher pressures.

The behavior of No. 10 may be instanced as typical of these. The pressure was raised to 10 tons, when the joint opened, releasing the pressure. After tightening, it was raised to 13 tons, when it stretched again. By alternately stretching the casting and tightening the valve-joint the pressure was ultimately raised to 19 tons. After this the walls of the cylinder were machined down to ⅝-in. thickness over two-thirds of its length. The cylinder was then tested again. The pressure was taken up by stages to 18 tons without fracture. At this stage the walls had bulged so much that the outside of the cylinder had the appearance of a stressed test-piece of the alloy. By the next day the recorded pressure had fallen to 16 tons. The wall-thickness was then reduced to ¼-in., and the cylinder again tested. It passed through a similar series of tests and remained unbroken at the end. (See Fig. 3.) No doubt if this treatment had been sufficiently prolonged, the cylinder could have been fractured, but this would only have taken place after the hardening produced by the water-pressure had raised the yield-stress to the same figure as the ultimate stress.

These tests showed that it is possible to cast cylinders of aluminum-bronze both in chill and sand molds, which are not burst by water-pressures of 18 tons per sq. in. Their only drawback was that they began stretching at pressures of 10-12 tons, the sand castings giving the lower figure as might have been expected. These results were encouraging in spite of the fact that, although the sand castings had apparently been produced under the same conditions only three out of six were sound. Accordingly it was decided to experiment with a stiffer material by raising the aluminum percentage in the bronze.

A bronze containing 9.5% of aluminum was cast and tested. It stood up to 11 tons pressure before bulging, and then behaved similarly to the 9% bronze. A 10% bronze was cast. This was tested up to 12.5 tons before expanding. By alternately tightening the valve-joint and exerting pressure 18 tons were recorded. Next a 10.5% bronze was cast. This stood up to 14 tons before the joint had to be tightened, after which 18 tons pressure was obtained. The wall-thickness was then reduced to ⅜-in. On re-testing, the cylinder burst at 17 tons pressure, there being considerable extension of the kind shown on Fig. 3, No. 10. Finally an 11% aluminum-bronze was cast. This withstood hydraulic pressure extremely well. The pressure was taken up to 20 tons without any sign of leak. The wall-thickness was then reduced to ⅜-in.. On re-testing, 18 tons were recorded before the cylinder burst. Its appearance is shown in Fig. 3, No. 13c. The fracture of this material is quite different from that of the 15% gun-metal used in the earlier experiments. It is confined to a small area, and a decided extension is observed. In this respect it is undoubtedly superior, showing itself to be a tougher alloy.

One of the conclusions reached by the authors in the Eighth Alloys Research Report was that 11% of aluminum represented the limit of the serviceable bronzes. It appeared of interest to test this conclusion in the present case. A bronze containing 11.5% of aluminum was cast and tested. It held 15 tons pressure and then burst with no extension. Thus it showed itself clearly inferior to the 11% bronze.

Table I. summarizes the results obtained with bronzes cast in green sand, and containing between 9 and 11.5% of aluminum.

TABLE I.

Aluminum, per cent.	Gage pressure at which the valve-joint began to leak, tons (of 2,240 lbs.) per. sq. in.	Maximum pressure to which the casting was subjected. long tons per sq. in.	Wall-thickness of cylinder under test, inch.	
9.0	10	19	¼	cylinder unbroken
9.5	11	15	⅜	" "
10.0	12.5	18	⅜	" "
10.5	14	18	⅜	cylinder burst
11.0	no leak	20	⅜	" "
11.5	no leak	15	⅜	" "

The gradual "stiffening" of the castings by increasing the aluminum is well brought out. Up to 10% of this element, it is practically impossible to burst a sound casting by hydraulic pressure owing to the gradual stretch of the material. The most serviceable bronzes under this test are those containing from 10.5-11% of aluminum. They are stiff and tough alloys, and break with considerable extension. The 11.5% bronze is a brittle material, markedly inferior to these.

Fig. 6. Aluminum-Bronze Test Piece for Tensile Tests.
(Cast in sand under the same conditions as the valve blocks.)

Four more castings of the 11% bronze were made under the same conditions. One of these failed to pass the preliminary test. Its unsoundness appeared to be caused by dross. The other three held water-pressures up to 19 tons. They were machined down to ⅜-in. wall-thickness. On re-testing, they behaved similarly to 13c, that is, they stood up to 18 tons without leaking, and then burst, the form and position of the fracture being also similar.

The investigation had now been advanced to the stage that cylinders of aluminum-bronzes could be cast in ordinary green-sand molds, which, except for an occasional failure, were capable of holding hydraulic pressures of 15 to 20 tons. By varying the exact percentage of aluminum, considerable latitude as regards ductility and strength had been obtained. Alloys of suitable composition thus appeared to have been found.

Casting Troubles and Their Solution.

The next step was to produce castings of these bronzes in more complicated forms. The type chosen was a hydraulic valve-block, such as is used in high-pressure hydraulic pumps, and consisting of a lug, barrel, and base-plate. The valve-block was cast with a riser on the lug, such as is shown on Fig. 4, except that the riser was smaller. The position of the gate was also somewhat different. The general arrangement, however, was similar. Fig. 5 shows the valve-block after it has been machined for testing. Its dimensions are as follows: Lug.—Diameter, 2⅝ ins.; height, 2 ins.. Barrel.—Length, 8½ ins.; diameter, 2⅝ ins. at wide end; 2 ins. at narrow end. Base-plate.—5⅝ by 4 by ⅜ ins.

Two valve-blocks of the 11% bronze were cast. Neither of them was successful, although the metal was clean and precautions were taken to keep a good head of fluid metal during the solidification. On cutting off the riser at A B, Fig. 4, it was found that a number of draws were present, distributed radially across the lug. These might have been caused either by the trapping of gas bubbles set free during the freezing of the metal and their being drawn out as the crystals grew, or by a difference in the coefficient of contraction of the two structural constituents of the alloy. Two casts of the valve-block in the 10.5% bronze were then made. These were also unsound, but the faults appeared to be due not to draws but to dross, which crept through the skim-gate and was deposited on the near side of the barrel.

With a view to simplifying the problem, the base-plate was removed, and only the barrel and lug cast. Five such castings were made in the 10.5% bronze. Only one of them stood the high-pressure hydraulic test (15 tons). Even this was not quite free from dross. The others were all more or less contaminated in this way, even though various methods of trapping it were used. Two of the castings showed sponginess in the lug, and one of these showed piping as well.

The authors' first attempts were directed to the problem of obtaining clean metal, leaving the piping and sponginess for later work. Experiments were made to clean the fluid metal by the addition of certain deoxidizing agents and fluxes. [Magnesium, Calcium Silicide, Sodium Carbonate, Borax, Manganese and Tin were tried without success.—Ed.] In spite of the fact that these experiments all failed to give satisfactory castings, they were productive of valuable information as to how the dross gets into the finished castings.

The pure aluminum-bronzes are very viscous in the liquid state even at the highest temperatures. They pour "thick" and "sluggish." This sluggishness is not directly due to the metal itself, but to a tenacious film of alumina, that is, oxide of aluminum, which invariably covers the surface of the alloy. This can be demonstrated by giving a crucible full of the alloy a rotary movement with a stirrer and noting the surface. It will be seen that the surface film quickly comes to rest while the metal immediately below is still moving rapidly. Accordingly it may be concluded—and it is a deduction which the authors' later work supports—that the liquid metal does not offer any unusual resistance to the natural tendency of the dross to rise to the surface. Since in all cases particular care was taken to have the metal perfectly clean before pouring, the authors were convinced that the dross was in some way formed inside the mold.

By using a large riser on the lug, it was possible to see the metal enter and gradually fill the mold. The metal entering the mold through the well at the bottom of the gate was quite clean. On this metal a skin of alumina formed at once. If, as in the authors' earlier experiments, the metal enters quickly, ripples or waves are formed which break through this skin and expose fresh surfaces of clean metal, which are immediately oxidized. The perpetual recurrence of this process causes the formation of a large amount of dross. This is not carried out of the mold through the riser. The moment it comes in contact with the sides of the mold it sticks. This is why it is present in the castings, and particularly in the upper part. Thus any factor which produces ripples or any other kind of agitation of the metal, causes a much larger surface to be exposed, and so more alumina is formed. This skin of alumina is tenacious and very refractory. Consequently, when two or more ripples overlap, the skin prevents the metal from uniting.

It follows from the foregoing that the aluminum-bronzes should be poured as quietly as possible, and every care should be taken to prevent the metal being agitated after it has entered the mold. All subsequent casts of these bronzes have been made in accordance with these principles, and all difficulties caused by dross have disappeared. With care and a little practice, castings can be made with regularity that are absolutely free from dross, if the following precautions are adopted:

(1) The metal should be poured very slowly.

*"Proceedings" of the Institution of Mechanical Engineers, 1907, Part I., p. 57.

(2) The gate should be so arranged that the metal enters the mold at the lowest possible point. Broadly speaking, any form of gate will do, but the authors' conclusion is that it is decidedly advantageous to provide a sort of well at the bottom, and use rather a narrow opening. (See Fig. 4.)

(3) In the case of green-sand molds, wet sand must be guarded against, particularly in the lower parts of the mold where the metal rests on the sand. If a rather close sand is used it is far safer to dry the surface of the lower part of the mold.

Under these conditions the metal enters the mold quietly. As it spreads out the skin of alumina is stretched and broken, and fresh alumina is formed until, as in the castings under consideration, the full length of the barrel is occupied. As the metal rises, this skin is not broken but is pushed up until it reaches the upper surface of the mold. After this the metal mounts the riser, pushing the skin until the riser is filled. The final result is a casting with a thin and approximately uniform skin of alumina containing perfectly clean metal inside.

Tests of Valve-Block Castings.

Adopting the above precautions, the authors cast four of the valve-blocks without base-plates from the 10.5% bronze and seven from the 10% bronze. These were, without exception, free from dross. The diameter of the bore in the lug and barrel was ¾-in.

Seven out of the eleven castings were satisfactory. They did not stretch until pressures of from 12 to 14 tons had been reached. All of these were tested up to 15 tons, and two of them up to 18 tons. Owing to the ductility of these bronzes the labor involved in fracturing them under this test would have been excessive. It was not attempted, particularly as the authors had reason for thinking that the pump was likely to fail first. The tests given are quite sufficient to demonstrate the capabilities of the bronzes, and are severer than are likely to be realized in practice.

Three of the four bronzes which failed contained (intentionally) small amounts of manganese, the object being to see whether the radial slits that are sometimes found in the riser and lug could be prevented. These castings were all spongy, and two of them were piped in the lug. Manganese really accentuates this difficulty instead of removing it.

In this type of casting the best results were obtained with the 10% bronze, whereas the smaller cylinders first tested could be satisfactorily cast in the 11% bronze. These bronzes consist of mixtures of two constituents at ordinary temperatures, namely, the compound Cu_2Al and either a solid solution of aluminum in copper, or a compound Cu_4Al. The composition varies somewhat with the rate of cooling, the two constituents being soluble in one another at temperatures above 530° C. (934° F.). These constituents doubtless possess different coefficients of contraction. In small castings which cool relatively quickly, there is a less perfect separation of the constituents, corresponding to equilibrium at any particular temperature, than in large castings. Consequently the differences of contraction are more marked the larger the casting, and there will be a greater liability to contraction stresses, which cause weakness and in extreme cases unsoundness. This is the probable explanation of the difference noted above. In still larger castings the authors have found it advantageous to diminish the aluminum to 9.75-9.5%.

Microscopical examination has shown that the structural constituents of a given aluminum-bronze are similar, no matter whether the casting is large or small within the limits examined by the authors. The structures of the large castings are naturally somewhat coarser, but not very markedly so. They appear, however, just as homogeneous as the small castings. This is a most important property of these bronzes.

BLOCKS WITH BASE-PLATES.—The same general principles were followed in casting the complete block. Preliminary experiments were needed to show the most suitable form of gate and well, and a larger riser was used. It was found advantageous to face the mold with a somewhat coarser sand. On account of the base-plate exposing a large surface to the bottom of the mold, it was more than ever necessary to dry the latter to ensure that the metal lie quietly on it. Fig. 4 shows the arrangement finally adopted, and gives the complete casting which weighs about 26 lbs. The valve-block machined and ready for testing (Fig. 5) weighed 14 lbs.

In the earlier experiments 10% bronzes were cast. Some of these exhibited a tendency to sponginess, chiefly in the lug; others were quite sound, and gave satisfactory tests. The later mixtures contained either 9.75 or 9.5% aluminum. Most of these were satisfactory, and Table II., based on 15 tests, summarizes their properties under the hydraulic test:

TABLE II.

Aluminum, Per cent.	Gage pressure at which valve-joint began to leak, tons (2,240 lbs.) per sq. in.	Maximum presure to which the casting was subjected, tons (2,240 lbs.) per sq. in.
10.0	11-12	17
9.75	10-11	15
9.5	9-10	14

The castings obtained in this way were invariably clean, but they were not always sound. This unsoundness usually took the form of pinholes in the lug, but sometimes appeared in the barrel.

For a long time the authors were unable to trace this difficulty to its source, but eventually the solution was found. Although the castings had been produced as far as possible under similar conditions, one important variable had been present, namely, the duration of the melting of the charge. The furnace worked more quickly at some times than at others. In some cases the charge consisted of pure copper and pure aluminum; in others, of gates and risers of the required composition left over from previous casts. The former took longer to melt. An important consequence follows from this variable, namely, a variability in the amount of gas dissolved in the charge. This quantity will increase with the duration of the melting and the absolute temperature, up to a limit. It will be higher for charges made from pure metals, on account of the greater solubility of gases in these.

This difficulty will always be present in making castings under the present practical conditions, namely, by melting in air. It can, however, be minimized, and in the case of the aluminum-bronzes this has been done as follows: After the melt has been stirred and cleared of dross it should be allowed to remain in the crucible as long as possible, before pouring. With the fall of temperature the solubility of the gas diminishes. Corresponding to this there is a liberation of dissolved gas. The lowest temperature at which these alloys can be cast (with slow pouring) is about 50° C. (90° F.) above the temperature at which the alloy begins to freeze. The latter is about 1,040° C. (1,904° F.), so that 1,100° C. (2,012° F.) represents in round numbers the lowest temperature at which it is safe to cast. After adopting these conditions, the number of castings showing pinholes or sponginess has been greatly reduced, and while this difficulty still appears occasionally, the authors are now able to produce an average of four good castings out of six.

Tensile Tests.

In view of the fact that large test-pieces give results more or less inferior to those obtained with the usual small test-pieces, cylinders 9 by 3 ins. were cast in sand under the same conditions as the valve-blocks. These test-pieces were thus slightly larger than the barrel of the block. They were machined so as to give a hollow cylinder with a ⅞-in. bore, and had the shape shown in Fig. 6. They thus presented considerable similarity to the actual barrel of the valve-block. The following results were obtained:

TABLE III.

Aluminum, per cent.	Ultimate stress, tons (2,240 lbs.) per sq. in.	Elongation on 2 ins., per cent.
9.0	25.04	29.6
9.5	28.01	21.0
10.0	26.23	13.0

These values, though not as good as those obtained with the small sand castings of the "Eighth Alloys Report," are satisfactory, in spite of the fact that each test-piece showed considerable sponginess. The specimens had been cast at temperatures varying between 2,192° and 2,282° F. In view of the fact that the average temperature was about 212° F. above that at which the best results with the valve-blocks had been obtained, another set of test-pieces of the same size was cast at 2,012°-2,058° F. They gave the following results:

TABLE IV.

Aluminum, per cent.	Ultimate stress, tons (2,240 lbs) per sq. in.	Elongation on 2 ins., per cent.
9.0	18.12	26.0
9.5	21.60	14.5
10.0	20.32	7.0

The fracture of these specimens showed that they were perfectly sound. Notwithstanding this, the tenacity and ductility were inferior to those of the unsound pieces cast at a higher temperature. Accordingly it appears as if some sacrifice of these properties must be made in order to obtain castings entirely free from sponginess or pinholes, so long as they were prepared under conditions which permit of the solution of gases during melting. The values in Table IV. approximate most closely to those of the hydraulic castings themselves, and may be regarded as typical. Though inferior to those in Table III., they are sufficiently good.

High-Pressure Steam Tests.

In the previous tests the aluminum bronzes containing from 9-11% of aluminum have been shown to be capable of holding hydraulic pressures of between 14 and 20 tons. These correspond to between 2,200 and 3,200 atmospheres' pressure. As these are well above the requirements of castings for high gas-pressures, the authors did not consider it necessary to initiate any special tests of this kind. There is no doubt that these bronzes possess the requisite qualifications for this purpose, so long as the gas is at the ordinary temperature.

The case is, however, different with high-pressure steam, particularly with superheated steam, because prolonged exposure at the temperature reached may cause a more or less rapid deterioration of the [illegible]. In this connection Dr. Rosenhain's data obtained [illegible] authors' 9.9% bronze are of interest. They [illegible] there is a steady decrease of tenacity with [illegible] perature, which is accompanied by a rise [illegible] up to 300° C. (932° F.), although the latter [illegible] somewhat irregular. The strength is "fai[illegible] maintained up to 350° C. (662° F.) after an [illegible] posure, but from 400° C. (752° F.) upwards [illegible] rapidly.

Although these results are encouraging as fa[illegible] go, they do not settle the point whether aft[illegible] month's exposure to high-pressure steam, th[illegible] would have deteriorated. Accordingly two [illegible] sure steam-valves were cast. As these were [illegible] thin (the wall-thickness being 0.25 in.) it w[illegible] safe to cast them with the 10.5% bronze. No[illegible] used. Each casting appeared perfectly clea[illegible] smooth surface. They were tested on the hydra[illegible] up to 1.5 tons pressure without showing an[illegible] tion or leak. One of them was tested for a [illegible] at a steam pressure of 180 lbs. per sq. in[illegible] this pressure satisfactorily. Arrangements [illegible] made to test them for a long period with hig[illegible] steam under "service" conditions. The result[illegible] tests will be communicated in due course.

Conclusions.

As a result of the foregoing experiments, co[illegible] with the data on the corrodibility of the aluminu[illegible] onze-given in the "Eighth Alloys Report" which [illegible] been extended and confirmed by Dr. Rosenhain and M[illegible] Lantberry in their appendix to the "Ninth Alloys [illegible] port," the authors think they are entitled to claim [illegible] most of the requirements of high-pressure castings [illegible] been met.

The combination of properties shown, so far [illegible] the authors are aware, is unequalled by any other bronzes and they venture to recommend their trial in cases where chronic difficulties are encountered with the use of gun-metals, manganese-bronzes, etc. The authors' tests are far severer than those demanded anywhere in practice. The conditions for producing a sound casting weighing 500 lbs. will not be the same in every detail as those given in this investigation, where no casting exceeded 36 lbs. in weight, but the fundamental principles will apply in both cases. In particular, the metal must be poured as quietly as possible, and every care taken to prevent it being agitated after it has entered the mold. In this way the dross is kept down to a minimum. The characteristic property of these molten bronzes of forming a tenacious film of alumina the moment a fresh metallic surface is exposed to the air, this film being irremovable by any deoxidizer or combination of fluxes, is really the key to the situation. It appeared originally as an enemy, and for a long time remained so. Such success as the authors have achieved is due to their having converted it into a friend, by utilizing its tenacity to protect the remainder of the fluid metal from oxidation.

The following quotation from a paper by Mr. Erwin S. Sperry,[2] which was published about the time that the authors completed their investigation, is of special interest, because his conclusions, which are based on practical foundry experience, are identical with those drawn above. So remarkable is the agreement that either statement would hold in all respects for the two cases—one admittedly practical, the other admittedly scientific.

"No copper alloy held out more promise at the time it was produced commercially, and none has proved more disappointing than aluminum-bronze. After much good and bad experience with it, I will frankly say that it is a bronze without a peer, and the early 'worshippers' of it did not overrate it by any means. The lack of success has been caused by the difficulty in casting it, and not from any absence of merit in the metal itself.

"Unlike the tin bronzes, there is no tendency for the aluminum to separate in different alloys and liquation has never been found to interfere. It is safe to say that it is the most homogeneous of known bronzes. Neither do aluminum-bronzes show the tendency to crystallize like the brasses or other alloys of copper containing zinc. Crystallization has never been found. They are, therefore, 'safe' alloys for construction purposes. To illustrate this point, I may say that thousands and thousands of small pins of cast aluminum-bronze (10.5% aluminum) have been used by the U. S. Government in the Springfield rifle. These pins, called 'firing pins,' were used for firing the cartridges, and were employed because steel would not stand.

"The greatest obstacle in the way of casting aluminum-bronze is its oxidation when melted. Whenever the surface of the molten metal is exposed to the air, a film of oxide of aluminum forms on it. The more it is exposed, the greater the amount. This explains why such a large amount of dross forms when alumin[illegible]

[1] "Proceedings" of the Institution of Mechanical E[illegible]neers, 1910, Part 1, p. 286.

[2] Reprinted from the "Brass World" in the "Mech[illegible]cal Engineer," Feb. 18, 1910.

bronze is being stirred. When allowed to remain at rest in a crucible, very little forms, as the surface of the metal is protected by the film already on it. It also shows why aluminum-bronze should always be poured with as little stirring as possible. Any agent, such as wet sand, which tends to stir the metal up, produces dross and the accompanying dirty castings. The more fluidly aluminum-bronze can be poured, the better the castings.

"To cast the aluminum-bronze without the presence of some dross on the surface is a very difficult matter; and theoretically the right method of doing it would be to cast in a vacuum or neutral atmosphere, so that no air would come in contact with the molten metal. This, of course, is not commercially possible. The only method in which it can be cast in a commercial manner is to prevent its being agitated while the pouring is taking place, either by stirring, too high a drop from the crucible to the mold, or by wet sand. The more quickly it can be poured, the smaller the quantity of dross. Dross which forms in melting may be skimmed off, but that which forms while the pouring is taking place enters the casting. The various skim gates, pouring from the bottom, etc., are all efficacious, as they serve to trap the dross and prevent its entrance into the casting. There is no addition that can be made to overcome the dross formation, nor will any flux obviate it. The secret, if it may be called so, seems to lie in preventing the entrance of the dross into the casting, and not in its formation.

While the presence of dross is the greatest obstacle encountered in the casting of aluminum-bronze, it may be said that the shrinkage is the next. All strong metals shrink considerably, and in the case of aluminum-bronze the shrinkage is equal to that of steel. Shrinkage is easily taken care of if a molder understands his business. By the use of sufficiently large risers and freedom from sharp corners in the casting, with an ample gate, any shrinkage may be readily overcome."

In conclusion, the authors desire to tender their warmest thanks to the Council of the Institution of Mechanical Engineers for substantial financial assistance towards the cost of this investigation.

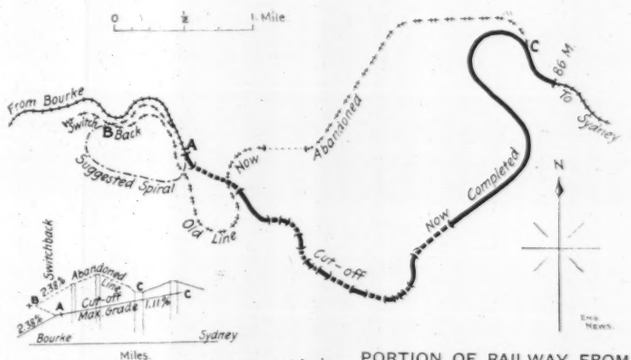
A Great Australian Railway Cut-Off.

[Contributed.]

A considerable improvement to the great Western Main Line railway of the State of New South Wales costing over $1,680,000, or $292,400 per mile, has just been completed. This line, about 500 miles long, exclusive of branches, after crossing some mountainous country soon after leaving Sydney, the capital, falls abruptly into the lower western country at about 90 miles from that city. Forty-two years ago, when the road was being built at that point, capital was scarce and the traffic comparatively insignificant and not expected to improve nearly so rapidly as it has since done, hence the late John Whitton, M. Inst. C. E., Engineer in Chief of the State Railways, adopted a switchback for the descent on grades of 2.88% combined with 11° curves, which served the traffic well for many years. It has been known in Australia as "the great zig-zag" to distinguish it from a smaller one on the same line nearer to Sydney and it has been one of the tourist sights of the colony. There were previously two works of a similar character close to Bombay on the Great Indian Peninsular Ry., but with these exceptions the device was new to British railway engineering.

The first proposal to get rid of the obstruction due to the zig-zag and the severe grades was in 1891, but this involved a long tunnel to reach directly the depression shown on the accompanying map at station 86 miles. This was on a steep grade against the heavier loading from the interior, and experience on similarly situated tunnels in the state was against the project, owing to the difficulties of ventilation in a hot climate in these cases, where the gases evolved on the steep ascent had to be dealt with. This scheme, the cost of which was estimated at $1,022,400, was therefore rejected. The necessity for the supersession of the switchback was well overdue when, as a result of complex studies in the field, five other projects came before the Public Works Committee in 1902.

It was shown that the traffic at that time of 5,188 freight trains yearly was much obstructed, the dead ends so limiting their length over the whole division that if a direct line were substituted the same duty might be effected by 3,900 trains, while the saving in passenger train time was put at 686 hours per annum. The results now obtained are very much greater, as the railway business of the state has been recently growing at the rate of about 60% in a decade. One of the schemes of 1902 consisted of a spiral, being a production of the lower dead end *A* (see accompanying figure) into the mountain and round to the point *B* above the upper dead end. But this, though the most economical of all in first cost, left the steep grading unaltered and the services of pusher engines for the 2.38% grades would have been still required.



PORTION OF RAILWAY FROM SYDNEY TO BOURKE, NEW SOUTH WALES. PLAN AND PROFILE OF OLD AND RELOCATED SECTION.

The other four proposals aimed at developing sufficient length to ease the grades without excessive curvature, while the tunneling, unavoidable in all of them, had to be broken up as much as possible in view of the ventilation difficulty. The selected one shown, as slightly modified since, obtained the very favorable grade of 1.11% with 6° 15′ curves, but most of the work being along the face of a precipice was very heavy indeed, involving no less than ten tunnels in little more than half its total length of 5¾ miles, and fills of up to 150 ft. between them. On leaving the lower dead end at *A*, going toward Sydney, the new line passes, by a tunnel of about 2,700 ft., under the now abandoned one, which, by the help of the zig-zag, was raised 350 ft. above it on the neck of the mountain as shown. Skirting the declivity which is cleft by numerous steep ravines, giving rise to the heavy section, easier ground is reached after the tenth tunnel, and the old line is regained at the low point *C*.

Owing to the position of the two longest tunnels each of them at opposite ends of the heavy portion of the cut-off, the delivery of materials and plant for the intermediate portion would have been greatly delayed if means had not been devised to gain access to it independently of the line itself. This was done by a funicular double line reaching down from the old line to near the center of operations on the new one, with a maximum slope of 1¾ to 1, the weight of the loaded cars being utilized to draw up the empties. A temporary power-house was installed also to drive the air compressors for the drills, the blowers for ventilation, for lighting the tunnels, and getting rid of the water which gave trouble in the water-bearing strata. The tunnels which are driven through more or less compact sandstone, are lined with concrete walls and brick arches, and the 4 ft. 8½-in. double-track is of 80-lb. rails. All the sharp curves have transitions on the cubic parabolic system in use in all the recent lines of the state. The cut-off is 52 chains shorter than the old one.

Ordinarily, the new railway construction of the state is carried out by the Public Works Department, and handed over on completion to the Railway Commissioners, who operate the lines. The latter, however, for obvious reasons, deal with regrading and other amendments of the existing lines, and have carried on this one by day labor, under their Engineer in Chief, Mr. James Fraser, M. Inst. C. E., Mr. W. J. Quodling, Assoc. M. Inst. C. E., being the Resident Engineer. The location surveys, however, were done by the Public Works Department under Mr. H. Deane, M. Inst. C. E., then Engineer in Chief, the writer of this contribution having been his principal assistant. To Mr. T. Kennedy, Assoc. M. Inst. C. E., is due the suggestion and working up on the ground of the route which was ultimately approved. Further improvement in the grades below and westward of point *A* have been authorized.

THE POPULATION OF 23 CITIES WAS OVERcounted, and of four was undercounted, in the 1910 Census of the United States, according to a bulletin issued by the Bureau of Census. In a number of instances deliberate fraud has been disclosed on investigation. Some of this fraud was in the nature of conspiracy between those who wished to swell the accredited population of the city and the enumerators. Following is a list of the overcounted cities with populations originally enumerated and as corrected, and with the amount of overcount in each case:

City.	As originally enumerated.	As corrected.	Difference.
Arkansas—Fort Smith	30,430	23,975	6,455
California—San Francisco	420,234	416,912	3,322
Idaho—Boise	19,782	17,358	2,424
Minnesota—Duluth	82,022	78,466	3,556
Minneapolis	306,076	301,408	4,668
Montana—Billings	12,428	10,031	2,397
Great Falls	22,324	13,948	8,376
Missoula	14,688	12,869	1,819
Havre	5,044	3,624	1,420
Oregon—Portland	222,959	207,214	15,745
Utah—Ogden	26,145	25,580	565
Washington—Aberdeen	15,598	13,660	1,938
Bellingham	27,194	24,298	2,896
Centralia	8,065	7,311	754
Everett	25,762	24,814	948
Hoquiam	9,154	8,171	983
Montesano	2,984	2,488	496
Seattle	248,382	237,194	11,188
Spokane	109,695	104,402	5,293
Tacoma	116,270	83,743	32,527
Walla Walla	20,273	19,364	909
Wisconsin—Superior	51,395	40,384	11,011
Wyoming—Rawlins	4,461	4,256	205

Investigations of possible undercounting were made in eight cities, but in only four did the additions to the original figures thus made exceed 3%. These four cities were Augusta, Ga., Atlantic City, N. J., Newburgh, N. Y., and Woodward City, Tenn.

On the general subject of undercounting and of errors in the enumeration of population, the bulletin already mentioned has the following to say:

It is probable that, taking the country as a whole, the population is slightly understated by the Census Bureau, but whether the margin of error is a fraction of 1% or amounts to as much as 2%, no one can possibly know. That it should exceed 2% is cercainly extremely improbable.

The most fundamental sources of error in census work are the absolute inability of the enumerators to personally reach every individual concerning whom information is required, and the ignorance of many persons themselves concerning the correct answers to the questions propounded to them. Other causes, which may be removed in whole or in part by changes in methods, are: The large number of questions on the schedules; the inclusion in the schedules of inquiries which many people cannot answer correctly except after prolonged consideration; lack of experience on the part of nearly all enumerators; lack of experience on the part of those supervising the actual work of collecting the statistics, namely, the supervisors of the census and their clerks and special agents; inadequate means for securing personal contact between the supervisory officers and the enumerators; the enumeration of the population on the basis of "usual place of abode"; the prolongation of enumeration over a considerable period of time; the unwarranted interference of private individuals and organizations with the taking of the census; and the amount and form of the payments to enumerators.

It is the intention of the Director, by careful study of the methods of census taking abroad and by other investigations, to attempt to discover whether means can be devised for materially improving the work of census taking in the United States; and in a future report the results of such inquiry will be presented, together with a further analysis of the sources of error under present methods. It may be that the present methods of taking the census secure results as nearly perfect as is possible, but the practicability of improvements in methods is clearly deserving of most thorough investigation and consideration.

A New Design of Steel Tie for Electric Railways.

Steel ties of a new type of construction are being introduced for the track of interurban electric railways; they have been laid already on two lines of this class (one of which has had them in service for about two years), and other railways have placed trial orders. The tie is composed of two transverse I-beams or channels from 24 to 36 ins. apart, connected at the top by two steel plates, and at the bottom by four steel straps or bars. These parts are riveted to the flanges of the I-beams, so that each tie is a rectangular frame. Under each rail seat or base plate is a concrete block, cast in place in the tie, and it is stated that ten men have concreted 300 ties in one day. In the track the ties are laid 18 ins. to 36 ins. apart, and are embedded in the ballast. In Fig. 1 are shown the ties as laid at different points between Altoona and Hollidaysburg, Pa., on the Altoona & Logan Valley Electric Ry.; and Fig. 2 shows one of the stretches of track laid with these ties.

The rails are secured to the base plates by a gib-and-cotter fastening, which is of the type used with some of the earliest steel ties on German railways. Each base plate is slotted for three fastenings. On each side of the rail flange are fitted three grooved gibs (Fig. 3) whose lower ends rest in the slots. One side of each rail has the gibs only; the other side has a vertical taper key or cotter driven into the slot, at the back of the cotter. The cotters are on the inside of one rail and the outside of the other, so that the rails are moved in the same direction when the cotters are driven down to tighten the fastenings. A tie is placed under each rail joint, which has thus a continuous bearing of 24 to 36 ins. in length. This is said to prove very satisfactory in practice. On these joint ties, the gibs hold the flanges of the angle splice bars.

The Cleveland Electric Ry., of Cleveland, O., uses these ties on 1¼ miles of a double-track line which carries a heavy suburban service and over which the interurban cars of the Northern Ohio Traction & Light Co. enter the city. For one mile the ties have 5-in. I-beams, while those for the remainder of the distance have 5-in. channels. The two beams (or channels) of each tie are about 30 ins. apart, and the base plates are 12 × 30 ins., 5/16-in. thick. The ties are laid 19 ins. apart in the clear. Each I-beam tie weighs complete (with fastenings) about 188 lbs. The track is laid with T-rails of the Am. Soc. C. E. 80-lb. section, Continuous rail joints and 12 ins. of stone ballast. An additional mile of this track is to be laid with the steel ties.

The weight in general for a 6-ft. tie is given as follows: 12 ft. of 5-in. 6.5-lb. channel, 78 lbs.; 5 ft. of ¼-in. 7.65-lb. plate, 38.25 lbs.; 10 ft. of 1.8 lb. angles, 18 lbs.; four sets of fastenings (1 lb. each), 4 lbs.; total, 138.25 lbs. The cost is given as $1.34 for the tie (at 2 cts. per lb.), 12 cts. for the fastenings and 30 cts. for the concrete; total, $1.76. With 16 ties on 33-ft. rails, this gives $28.16 per rail length, or $4,505 per mile. This cost is compared with ordinary track as follows: Sawed oak tie, 95 cts.; 2 tie-plates (at 20 cts), 40 cts.; 6 spikes (at 2 cts.), 12 cts.; total, $1.47. With 20 ties per rail, this gives $29.40 per rail length, or $4,704 per mile. Assuming a life of 20 years for the steel tie and 10 years for the oak tie the annual cost would be $225 and $470 per mile, respectively. The ties are not treated with any preservative coating. The makers estimate the life at 40 years, but this is open to very considerable doubt.

Where the rails must be insulated from the ties, the design provides for omitting the base plates and connecting the tops of the two channels by a pair of angles at each rail seat. The angles are set back to back and between them is a block of wood or other material whose base is fitted to a recess in the top of the concrete block. In this block is embedded another block in which are inserted a pair of threaded sleeves or bushes to receive the ends of screw spikes.

Fig. 4 shows this type of tie adapted to track construction in paved streets having a concrete base. The ties are 3 ft. wide and 3 ft. apart. This design includes a rail joint of the Clark type, in which the splice bars are riveted to the rails and the rail ends are welded to the base plate by the Thermit process. While no track has been built in this way, we are informed that several orders have been given. This tie is the invention of Mr. Wm. P. Day, of Cleveland. It is being introduced by the International Steel Tie Co., Hippodrome Building, Cleveland, O.

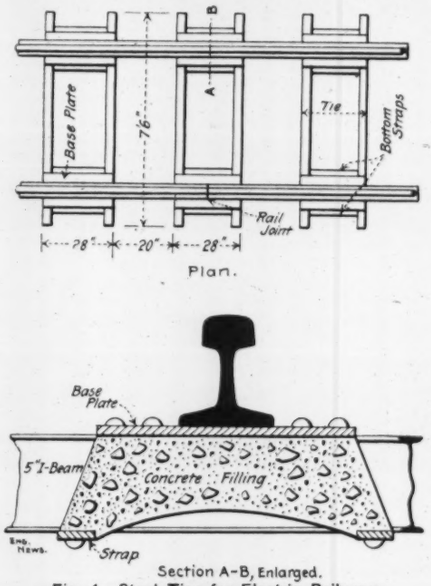


Fig. 1. Steel Ties for Electric Railways.
Wm. P. Day, Cleveland, Ohio.; Inventor.
International Steel Tie Co., Cleveland, Ohio; Maker.

FIG. 2. STEEL TIES ON THE ALTOONA & LOGAN VALLEY ELECTRIC RAILWAY; NEAR ALTOONA, PA.

Efficiency Tests of a 1170-Ft. Steam Pipe Line.

Tests on a steam pipe line 1,170 ft. long, designed for D. W. Mead, Consulting Engineer, by Mr. J. C. White and installed at the Schlitz brewery in Milwaukee, are discussed in Bulletin 347 of the University of Wisconsin entitled "Long Distance Transmission of Steam and Its Effect on Power Plant Economics." The line was designed to carry steam at 120 lbs. gage and 250° superheat for operating two pumps; one a 6,000,000-gal. centrifugal type, driven by a de Laval steam turbine, and the other a heavy-duty cross-compound pump of the same capacity. The pipe is of steel 4 ins. in diameter and ¼-in. thick with welded-flange joints which were closed by special steel gaskets. There were two bends, one of 51° and one of 90° and both of large radius. The pipe has a total drop in elevation of about 15 ft. It is covered with 2½ ins. of 85% magnesia covering and is enclosed in a concrete-lined tunnel 3 ft. high × 4 ft. wide. There is a manhole at each bend.

Four tests were run of two to four hours' duration, and readings were taken simultaneously at four points along the pipe line, every 15 minutes. Before these tests, a preliminary run was made to determine the condensation at no load. In this test, the water in the trap, before the steam receiver at the pumping station, was weighed for two hours. In the first two regular tests steam was used direct from the boilers without flowing through the separately fired superheaters in the boiler-room. The steam was passed through the superheating coils in the boilers, however, and received about 100° superheat. All tests were run with the turbine unit alone in operation, the output being varied from 2,500,000 to 4,000,000 gals. With the apparatus used, the number of B. T. U. per hour contained in the steam passing each of the four points was determined. The drop due to condensation, friction and radiation was found for each length of steel pipe. The efficiency of the entire line was determined by dividing the actual number of B. T. U. delivered at the pumping station per hour by the actual number of B. T. U. delivered to the pipe at the boiler-house. The pressure loss was also determined from readings at the four test points. The B. T. U. at any point was found from

$$[H + c\,(T_1 - T)] \times \text{lbs. per hr. passing,}$$

where H = total heat of saturated steam, T_1 = temperature of the steam, T = temperature of saturated steam at given pressure, c = specific heat of superheated steam. Reeves values of c were used, varying from 0.555 to 0.480 along a curve apparently hyperbolic.

It is seen that the efficiency varied from 99.52% to 94.50%, figures which may be considered high for a line of such length, which is accounted for by the unusually good construction. A mod-

RESULTS OF FOUR TESTS ON A 1,170-FT. STEAM LINE AT THE SCHLITZ BREWERY, MILWAUKEE.

Reading point.	Temperature.	Pressure.	Degrees superheat.	Specific heat.
Entering superheater	447.2	108	104.6	0.490
Leaving superheater	421.4	104.5	80.9	0.510
51° Bend	382.1	106.3	40.5	0.538
90° bend	363.8	101.2	25.5	0.556
Pumping station	362.7	101.1	24.5	0.558

Condensed steam, 7,085.2.....Total per hour, 3,603.6 lbs.
Condensation in pipe, 122.0 lbs.....Barometer, 14.5
Total, 7,207.2 lbs...Average temperature of tunnel, 72° F.

B. T. U. per hr. available entering superheater...4,430,237.8
B. T. U. per hr. available leaving superheater...4,421,980
B. T. U. per hr. available at 51° bend.....4,331,408.6
B. T. U. per hr. available at 90° bend.....4,254,636.6
B. T. U. per hr. available at pumping station...4,246,749

Equivalent HP. delivered $\dfrac{778 \times 4{,}246{,}749}{33{,}000 \times 60}$ 1,668

B. T. U. total loss in pipe (4,421,980 — 4,246,749) .....175,228.5 per hr.

B. T. U. condensation loss $\left[\dfrac{122}{2} - (1{,}185.5 + 0.534 \times 50)\right]$..... 73,932 per hr.

B. T. U. radiation and friction loss (175,228.5 — 73,932) .....101,296.5 per hr.

Total efficiency of pipe $\dfrac{4{,}246{,}749}{4{,}421{,}980}$ 96.0%

Total efficiency of pipe:
Three-hour test (without superheater)..... 99.52%
Four-hour test (with superheater)..... 94.5 %
Five-hour test (with superheater)..... 96.51%

erate degree of superheat, as used in the first two tests, gave the best results since the radiation and friction were small and the condensation was moderate. With high superheat the condensation was reduced to a minimum, but the radiation and friction became extremely large, giving a greater total loss. The average drop in the pressure of the steam in the line was found to be only 5%, as the pipe line was designed somewhat larger than necessary for the present equipment. The average total loss in B. T. U. of the first tests is about 194,000 B. T. U. per hr., or 162 B. T. U. per hr. per sq. ft. of pipe surface. The average drop in temperature of superheat was about 57° F. without passing the steam through the separately fired superheater, or 1° for 20 ft. of pipe. The drop during the last two runs, with high superheat, averaged 133°, or 1° for 9 ft. of pipe.

The Prevention of Street-Car Overcrowding in Several European Cities.

The U. S. Bureau of Manufactures, Department of Commerce and Labor, has secured, from the consular officers in several European cities, reports on the prevention of overcrowding of street cars. These were published in the daily consular and trade reports of Jan. 10, and the more important points have been reviewed in what follows:

LIVERPOOL.—It is reported that overcrowding has been entirely eliminated even in hours of heaviest traffic. The problem has been satisfactorily met by the local authorities placing upon the various tramway lines some 60% additional number of cars in the rush hours. Two distinct classes of passengers are carried (1) men employed in the shipping and along the line of docks, and (2) those employed in commercial offices. The first class goes to work much earlier than the latter, so that the morning traffic is more easily regulated than the evening. The regulation street car is double-deck, 28 ft. long, 16 ft. 8 ins. high. On the lower deck the seats are arranged along the sides, accommodating 22 people. On the upper deck the seats are transverse with a middle passageway and accommodate 38 persons. The only provision for those standing is by straps attached to a pole just under the ceiling of the lower deck. Standing on the upper deck is prohibited. Passengers board the cars at the rear, the step being of sufficient width to admit two, but a heavy rod divides the space and prevents crowding. The doors are wide enough to admit only one person at a time. On both decks are signs showing the number of passengers which can be accommodated. The conductors become efficient in keeping account of the number of persons who have boarded or left a car, it is said, and when the capacity is filled the gates are closed, indicating that no more passengers will be taken on. Cars operated in the business district since 1908 have provided for what was termed "first-class traffic." The results of operation have shown that it was advisable to reserve only the inside of the cars for such "first-class" passengers, the upper deck being open for all at the usual prices. This system has been reported satisfactory, and its extension to other routes has been sought.

The Liverpool Overhead Electric Railway runs along the docks for 6½ miles, or from end to end of the city. It was completed in 1893 and is reported still to be satisfactory, carrying an average of 24,000 passengers a day. Overcrowding in rush hours is eliminated by decreasing intervals between trains. A five-minute service is maintained in working hours and a ten-minute service until midnight. During the period when the dock men are going to and from work a half-minute service is run. These trains consist of two or three coaches each with a seating capacity of 45 passengers. Occasionally the station platforms become crowded, and then no tickets are sold until the trains have relieved the congestion.

BIRMINGHAM. — In Birmingham, England, standing in the street cars is prohibited, due, it is reported, to a desire to secure comfort for the passengers and to the use of a 3½-ft. gage system. When the weather is bad, and occasionally during rush hours, a few standing passengers are permitted. A few straps hang from the top of the car merely to assist passengers on entering and leaving. Handling of the traffic in this city is said to be assisted by the radiation of the lines in all directions from the manufacturing and business districts.

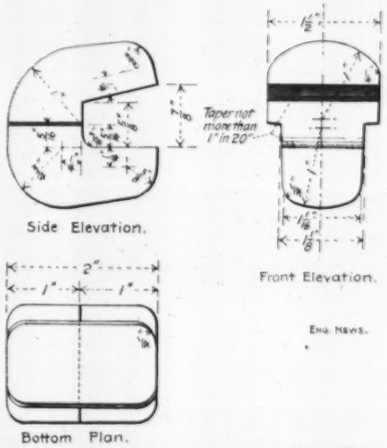


Fig. 3. Gibs for Fastening Rails to Steel Ties.

The city ordinances give the police authority to regulate loading and unloading. The passengers form two lines, one for the lower deck and the other for the top deck of the car, the upper deck being reached by winding steps, front and rear. The scheme is called the "queue system," and is used quite generally throughout the United Kingdom. Passengers board the cars at the front end and leave from the rear. When the car is full, the motorman draws a chain across the entrance and the conductor one across the exit, and no one is permitted to board until some one has alighted. Cars run on the left track of two-track lines. There is some complaint that passengers are delayed by the regulations prohibiting overcrowding. Delay is said to be most noticeable about one o'clock Saturdays, which is the commencement of a half holiday, and during bad weather. It is usual to start 76 cars at 5 a. m., the number being increased to 273 at 7.30 a. m., after which the number fluctuates. In the evening from six to eight o'clock, the number is 226. The traffic is all of one class without special service for higher fares, except that those who ride before eight o'clock in the morning have the advantage of a cheaper return fare.

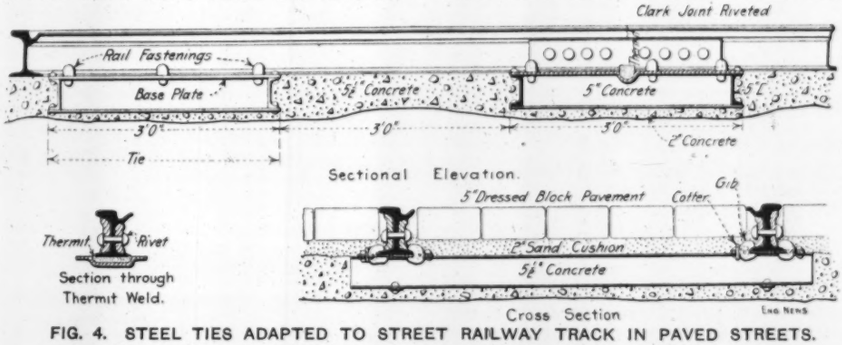


FIG. 4. STEEL TIES ADAPTED TO STREET RAILWAY TRACK IN PAVED STREETS.

MANCHESTER.—In Manchester, England, the population being very much spread out, the traffic on the municipal street cars has a large proportion of long-distance passengers. In the rush hours and in bad weather, four passengers are allowed to stand inside a small car and six inside a large car. The "queue" system is used at the terminals and busy squares. The regulations against standing or overcrowding have not been found to seriously delay the handling of crowds in rush hours, and seasonable service is generally secured with extra cars. The cars commence running at 5 a. m. and up to 7 a. m. tickets are sold at workmen's rates. Both one-way tickets and return tickets can be purchased at any time during the day. The ordinary 3 and 4-ct. fares are reduced to 2 cts. in this early morning period; 5 and 6-ct. fares to 3 cts. and 7 and 8-ct. fares to 4 cts. In the Borough of Salford, adjoining Manchester, the regulations provide that the women earning not more than $3.65 per week may travel at workmen's rates until 9 a. m. and may purchase return tickets at cheap rates at any hour.

BELFAST.—In Belfast, Ireland, there are three classes of passengers, the rates for which are about 6 cts. per mile first-class; 4 cts. second-class, and 2 cts. third-class, the minimum fare being intended especially for working people. Overcrowding is prevented by the conductor closing the gate of the platform when the capacity is reached. Under certain conditions, eight passengers are allowed to stand on each deck. No difference is made in the service, and all persons have the same privileges.

MARSEILLES.—In Marseilles, France, the leading industrial plants are scattered about the city, so that no great difficulty is found in preventing congestion even during rush hours. At the beginning and close of general business, and in the noon hour, the service is doubled, or even tripled, on certain lines by means of trailers. The overhead-trolley system is used, most of the cars being of a semi-convertible type about 30 ft. long accommodating 49 persons, 21 seated inside and 28 standing on the platforms. The trailers are 25 ft. in length. No double-deck cars are used. All the cars contain a card on the front and rear platforms and in the interior showing the number of seats provided and the amount of standing-room. The service is ungraded and there is no classification of passengers or compartments. The fare is equivalent to 1.93 cts. within the city limits, except for circular trips when the charge is 2.89 cts. No transfers are given.

BERLIN.—In Berlin, Germany, there are electric and steam city and suburban lines, electric elevated and subway and electric surface lines. The increased traffic of rush hours is accommodated by decreasing the headway of trains and cars and by adding trailers to the surface cars. Also on the elevated and subway lines, the size of trains is increased. It is a police regulation that the number of seats and standing places must be posted on the cars. A greater number of passengers than the posted capacity may be carried as follows: (1) on week-days between 11 p. m. and the close of the regular schedule; (2) during sudden showers, snow-storms, etc.; (3) when traffic is interrupted; (4) on occasion of parades, festivities and large functions; (5) on Sundays and holidays from 3 p. m. until the close of the regular schedule. During bad weather and interruption of traffic, one extra person may be carried on the front and rear platforms, two in cars having longitudinal seats and three in cars having cross seats. Violation of these regulations is punishable by a fine or imprisonment. In omnibuses, an excess of passengers is not permitted, owing to laws for the prevention of cruelty to animals. Low-rate tickets are issued by the electric and steam city and suburban lines to bona fide workmen. The tickets are good for one week and entitle the holder to ride at any time of day or night. The electric surface lines also have special tickets for workmen and school-children; good for one week and costing the equivalent of 11.9 cts. if to be used once a day and 23.8 cts., if to be used twice daily. Such

tickets are good only before 7 a. m., and after 5 p. m. School tickets are issued for periods of one to twelve months without restriction, and cost 71.4 cts. a month when used on two lines and 23.8 cts. for each additional line.

MOSCOW.—It is reported that the absence of strap hanging and crowding in Moscow, Russia, and the civility of conductors and motormen are remarkable. The cars seat 26 persons, with standing room for eight on the rear platform of the trailers. No one is permitted to remain standing in the car. Motormen and conductors are held liable for the enforcement of these rules. Passengers disobeying the regulations are turned over by the conductor to a policeman who files charges against the guilty ones for infraction of the laws. Such ordinances are reported to delay immense throngs of people at certain times a day, and it is a familiar sight to see scores at the principal centers waiting during the rush hours of the morning and evening. Extreme congestion is prevented, however, by the addition of extra cars, mostly trailers, and by decreasing the headway. Passengers are admitted by the rear platform and leave at the front. Both gates on the front platform are closed while the car is running. When the car stops, the gate on the right-hand side of the stopping point is opened for exit. The gate on the left-hand side of the rear platform is always closed in running, and the one on the right-hand side is closed when the car carries the prescribed number of passengers.

Besides bearing signs indicating the route of the car, each car in Moscow carries a large round target on which is printed a number in bold black figures. These targets are fastened on the edge of the roof over the front and rear platforms. Small reference books containing the routes of the various cars according to numbers are sold by conductors for the equivalent of 5 cts. At large squares, where several lines center, the numbers are fastened over the respective tracks of the different lines, so that the passengers know the exact place at which to wait for a certain car.

Each passenger is presented with a ticket which he must preserve until he leaves the car. He must exhibit the same to the inspector, who may board the car at any time. Only one class of service prevails in Moscow, the fare being 5, 8, 10 and 15 kopecks (2½, 4, 5 and 7½ cts.), according to distance. Reduced fares of 3, 5 and 6 kopecks are charged from 6 to 7 a. m. for workingmen. Special rates are given to students of the numerous educational institutions.

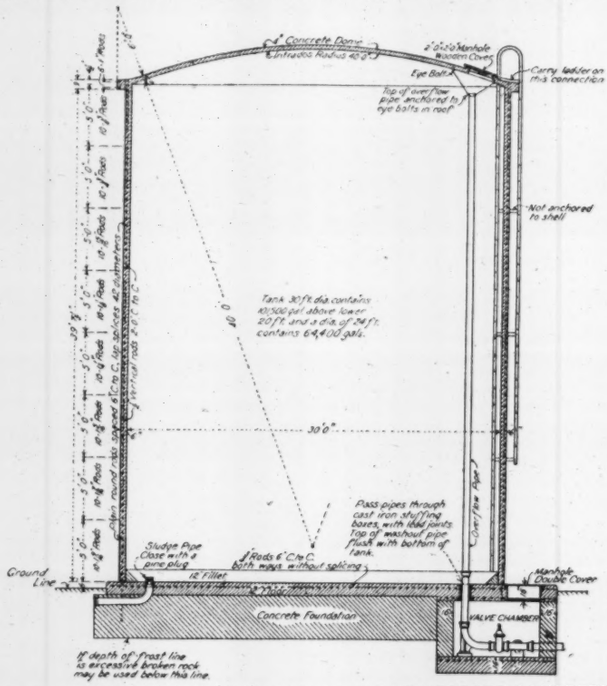
A RAILWAY ELECTRIFICATION COMMITTEE has been appointed by the Association of Commerce (Chicago) to investigate the problem of converting the steam railway terminal lines to electric traction. The railways are represented on the committee by Mr. H. G. Hetzler, President of the Chicago & Western Indiana Ry.; Mr. W. A. Gardner, President of the Chicago & Northwestern Ry.; Mr. Darius Miller, President of the Chicago, Burlington & Quincy Ry., and Mr. C. E. Schaff, Vice-President of the New York Central Ry. The city is represented by the Chief Smoke Inspector, the Health Commissioner (Dr. Evans), the chairman of the City Smoke Commission and the chairman of the council committee on local transportation. The other members are Dr. W. F. M. Goss, M. Am. Soc. M. E. (University of Illinois), Mr. M. B. Starring, President of the Northwestern Elevated Ry., and several business men. The committee will appoint a chief engineer and engineering staff and will maintain permanent headquarters.

Specification for a Reinforced-Concrete Railway Water Tank.*

The capacity of the tank shall be within the limits of 50,000 and 100,000 gals., exclusive of the lower 20 ft. of the tank. The height of the tank from bottom to top of shell shall be 40 ft. A diameter of 30 ft. is recommended. The tank is designed to deliver water to locomotives through water columns. The floor of the tank shall not be lower than the tracks served.

Foundation.—The foundation shall consist of a disk of concrete. If the depth of frost is excessive, this disk may be carried on broken rock compacted in the bottom of the excavation, but the minimum vertical thickness of the concrete foundation, exclusive of the tank floor, shall be 42 ins.

Valve Box.—The valve box for the piping shall be constructed as a part of the foundation. The top and bottom shall be reinforced by steel rods laid both ways and doubled around the pipes and the manhole. The manhole frame shall be in one piece of first-class cast-iron with a double seat and a double cover. The latter shall preferably be of wood. When low temperatures make it necessary to prevent freezing within the valve box, an air space shall be constructed in the middle of that portion of the box walls outside of the tank foundation. When the absence of low temperatures permits, the air space and the lower manhole cover may be omitted.


4" Concrete Dome
Intrados Radius 40 ft.
2'-0"x3'-0" Manhole Bronze Cover
Eye Bolt
Carry ladder on this connection
Top of overflow pipe anchored to eye bolts in roof
Not anchored to shell
Tank 30 ft. dia. contains 100,500 gal. above lower 20 ft. and a dia. of 34 ft. contains 64,400 gals.
30'0"
Pass pipes through cast iron stuffing boxes with lead joints. Top of washout pipe flush with bottom of tank.
Overflow Pipe
Sludge Pipe Close with a pine plug
12" Fillet
Ground Line
Manhole & Double Cover
Concrete Foundation
VALVE CHAMBER
If depth of frost line is excessive broken rock may be used below this line.

DESIGN FOR A RAILWAY WATER TANK OF REINFORCED-CONCRETE.

Floor.—The floor on the foundation shall be constructed, giving its surface a sidewalk finish without plastering.

Shell.—The shell shall be constructed as shown, building in the concrete fillet in the angle at the bottom.

Roof.—The roof, including manhole and cover, shall be constructed as shown, finishing top of roof as specified for the floor. Where ice will not form to an injurious or troublesome extent and sunlight will not cause vegetable growth in the water, this roof may be omitted at the discretion of the engineer.

Concrete.—The concrete in the tank foundation and the side walls of the valve box shall be a 1:3:5 mix, made and laid in accordance with the specifications of this Association for Portland cement concrete.

Reinforced concrete shall be a thoroughly uniform mixture of cement, sand, stone and water completely enveloping the reinforcing rods.

The volume of the sand shall be 5% in excess of the volume of the voids in the stone. The volume of the cement (considering 100 lbs. of it as 1 cu. ft.) shall be 25% in excess of the volume of the voids in the mixed sand and stone. The engineer shall determine the voids and proportions.

The volume of the water shall be sufficient to give the concrete a fluidity that will cause it to flow and mold itself in the forms without tamping.

The concrete shall preferably be mixed by [illegible] machines. The method used shall yield a [illegible] even mixture.

The concrete, after mixing, shall be poured [illegible] into final position in the forms before its [illegible] complete, and it shall not thereafter be [illegible] it is thus placed, it shall be thoroughly worked [illegible] flat, thin-bladed tools in a manner that will [illegible] voids and air pockets and produce unbroken [illegible] faces against all forms and secure perfect [illegible] with every part of all reinforcing rods.

The surface of concrete shall be clean and [illegible] concrete is laid thereon. The surface, if hard [illegible] also be mopped with cement grout immediately [illegible] vance of placing fresh concrete. Smooth [illegible] mortar surfaces shall be avoided where additional concrete is to be placed. If necessary, as in [illegible] between the tank floor, shell and fillet, old surfaces shall be tooled, cleaned and grouted before concrete is placed thereon.

A rapid drying out of concrete shall be prevented by regular, frequent and continued wetting until danger of arrested setting and hardening is past, as the engineer shall direct. Freezing of concrete before it has finally set shall be prevented.

Any concrete broken or displaced in any manner after having set shall be removed from the work.

Materials.—The cement shall conform to the specifications of this Association. The sand shall be clean, sound and sharp and it shall be of graded size, giving a minimum of voids. The stone shall be clean, sound and durable. The word "stone" includes broken rock and gravel. The stone shall be of graded sizes, giving a minimum of voids. All of it shall be fine enough to pass through a circular hole having a diameter of ¾ in.

Forms.—The concrete forms shall be made of metal or of dressed and matched lumber. They shall be accurately made and erected, be water tight, and shall have ample strength and rigidity to prevent bending and warping under the load and action of the concrete. They shall be erected in such sections and courses as will permit the concrete to be poured and worked as above specified. No device for holding the forms that would leave a hole through the concrete shall be used. Wires passing through the concrete shall be nipped off beneath the concrete face.

Pointing.—Any break in the concrete surfaces not impairing the integrity of the structure shall be pointed with cement mortar, as the engineer shall direct. Any other imperfections in the concrete shall be treated and remedied as the engineer shall direct.

Reinforcement.—The concrete shall be reinforced by steel rods of the form, size, number and arrangement as shown. They shall be wired at intersections with each other and be maintained in required position as they are buried in the concrete, at which time they shall be free from dirt and scale. Splices in rods shall be lapped 42 diameters or sides. No splice shall be opposite a splice in an adjacent line of rods. Throughout the splice the ends of the rods making it shall be 1½ diameters or sides apart in the clear. There shall be not more than four splices in the circumference of a tank 30 ft. diameter. Unnecessary splicing shall be avoided.

Reinforcing Rods.—The reinforcing rods shall be plain or deformed. Their tensile strength shall be between 60,000 and 90,000 lbs. per sq. in. Their elastic limit shall be not less than half their tensile strength. They shall not be stressed more than one-third of their elastic limit. Any rod shall be capable of being bent cold on a radius of three diameters or sides through 180° without sign of fracture.

Waterproofing.—A dense, even mixture of concrete as herein specified for reinforced concrete shall be the primary expedient to secure water-tight concrete. This may be supplemented by mixing with the cement some form of waterproofing compound of proved efficiency and now obtainable from manufacturers.

Where the concrete can be worked before it has set, the surface shall be thoroughly troweled until a dense mortar face is secured. Concrete surfaces already set may be plastered by rich cement mortar, but surfaces so treated shall first be cleaned and roughened by steel brushes or equivalent, and the plastering shall be applied on a fresh coat of cement grout mopped on the surface.

In addition, if necessary, separate and alternate washes of soap and alum in the order named shall be applied to the dried and hardened concrete surface. The number of washes should be not less than two of each, with a 24-hour interval between each. The proportions should be approximately ¾-lb. of soap and ⅛-lb. of alum per gallon of water. These proportions may be varied if better results are thereby secured. The soap wash shall be applied boiling hot, without causing froth. The alum wash should have a temperature between 60 and 80° F.

In lieu of these washes approximately 1%, by weight, of powdered alum may be evenly mixed with the cement, in which case the same proportion of soap shall be dissolved in the water in making the concrete.

In lieu of soap and alum, waterproofing paint having an asphalt base to be applied hot or cold, and now ob-

*These specifications were submitted (as a suggested form only) by the Committee on Water Service at the annual meeting of the American Railway Engineering and Maintenance-of-Way Association, at Chicago, March 21, 23. We give only those parts of the specifications which relate to the concrete work.—Ed.

tainable from manufacturers, may be used. In all washing or painting the concrete surface treated shall be dry and clean and the temperature should be above the freezing point.

Loads.—The weight of water shall be assumed to be 63 lbs. per cu. ft. Wind pressure, acting in any direction, shall be assumed to be (in lbs.) 30 times the product of the height by two-thirds of the diameter of the tank (in ft.).

Annual Convention of the American Railway Engineering Association.

The American Railway Engineering Association is the new and more convenient name of the American Engineering and Maintenance-of-Way Association, the change having been adopted by a large majority vote on letter ballot. The 12th annual convention was held at the Congress Hotel, Chicago, March 21, 22 and 23. There were six business sessions, and one evening was occupied in part by an illustrated lecture on steel rails, by Mr. M. H. Wickhorst, Engineer of Tests for the association's committee on rails. This lecture was followed by a "smoker," and the only other entertainment was the annual banquet on the second evening. The attendance was large, and there was the usual evidence of very active interest in the consideration of the various subjects submitted and discussed. The proceedings opened with the address of the President, Mr. L. C. Fritch (Chief Engineer, Chicago Great Western Ry.); this reviewed the purpose, policy, organization and growth of the association, and touched upon some developments in railway affairs and railway engineering. The reports of the secretary and treasurer showed a membership of 967, and financial conditions as follows: balance of March, 1910, $15,382; receipts, $26,423; expenditures, $28,593; balance of March, 1911, $13,217. The officers for 1911 are as follows: President, W. C. Cushing, Chief Engineer of Maintenance of Way, Pennsylvania Lines (Southwest System), Pittsburg, Pa.; Vice-Presidents, Charles S. Churchill, Chief Engineer, Norfolk & Western Ry., and Edwin F. Wendt, Assistant Engineer, Pittsburg & Lake Erie Ry.; Treasurer, Geo. F. Bremner, District Engineer, Chicago, Burlington & Quincy Ry., Secretary, E. H. Fritch, 962 Monadnock Block, Chicago.

In the proceedings there was evident the usual difficulty in keeping the discussions to the really important matters. In several cases time was spent in discussing minor matters of wording or phrasing while matters of general principle or larger importance were passed by. A good part of the discussion also related to proposed changes in the "Manual of Recommended Practice," published by the association, and while it is desirable to have this accurate and complete it should be recognized that the manual is not a statement of the best and only practice, to be accepted and used as the highest authority. It is simply a compilation requesting and suggesting approved methods in certain lines of work. The value of the committee reports is largely in their collection of information and opinion, and the value of the meeting is largely in its opportunity for discussing the material thus presented.

Every one of the 19 standing and three special committees had a report, and all the reports were called up for consideration. Naturally some received much more attention than others, and for some of them there was little or no opportunity for discussion. This was inevitable, when 22 reports had to be disposed of at six sessions. One trouble with the work of this association is that its enthusiasm has led it to undertake rather too much work. Some of the committees had from four to eight subjects assigned to them, and while not all of these were taken up in detail, their consideration serves to disperse rather than to concentrate the energy of the committee members. It is true that in some cases the work is divided among subcommittees, but it would be better to have the full committee give its attention to a smaller field of investigation. Furthermore, the various reports and appendices swell the annual volumes of "Proceedings" to an undesirable extent.

A change in some of the methods of management and procedure is necessary, and that these conditions are recognized by the officers of the association is shown by the fact that a part of one session was devoted to a frank discussion of them. At the same time, the subject of continuing the publication of the "Manual" was discussed. It was the universal opinion that this should be continued, but that it should be under control of a board of review to see that the matter is properly condensed, that unnecessary matter is not included, and that there is proper harmony and agreement between the various recommendations. It was originally intended to become a book of standard specifications, but its present most useful purpose is as a hand-book of good and approved practice in different lines of work.

All the reports were printed in advance, with their appendices and illustrations; they aggregated some 670 pages, exclusive of the 550 pages of the Rail Committee report (which forms one complete volume of the 1911 "Proceedings"). We give below a brief review of the reports and of the proceedings in connection with them. Abstracts of important parts of several of the reports we shall publish separately.

Roadway.

The work of this committee is divided among five subcommittees, only one of which had a report. This was an excellent one, however, and dealt with the one subject of formulas for waterway openings. Special efforts have been made to bring together all known formulas for determining the size of such openings, and appended to the report was a digest of information compiled by A. F. Gilman and G. W. Chamberlain (Univ. of Wisconsin) in the course of their investigation on this subject. About 27 formulas were given and discussed (beginning with that of Major E. T. D. Myers, 1879). There was also an extended bibliography accompanying the report. The committee stated that it was not prepared to modify its former conclusions that "no single waterway formula can be recommended as fitting all conditions of practice. Nevertheless, as a result of its investigations it felt warranted in calling particular attention to certain relationships which point to the development of such a general formula. The report was accepted as information, without discussion.

Rails.

This committee is conducting a comprehensive and systematic investigation with a view to improving the quality of rails. Its report proper was only one of progress, but the reports of its work for the year (including the investigations by Mr. M. Wickhorst, its Testing Engineer) fill a volume of 550 pages. Among this material is a large collection of information and engravings relating to rail failures, and to the use of rails of open-hearth and alloy steels. One important indication of the committee's work is that differences in the production of ingots and of the finished rails from them may annihilate all advantages that might be derived from any particular section of rail. The design of rail sections, therefore, is not the main cure for defective material. As a matter of fact, the principal defects connected with rail manufacture seem to have their origin in the making of the ingot. Some tests have been made as to the strength of rail head in different sections, in order to throw light on the controversy as to the respective merits of thin and thick heads. These tests will give some information also as to the claim that the rail head is broken down by excessive wheel loads even though there is no physical defect in the metal.

The discussion related mainly to rail breakages and records of breakages. It appears that on some roads from 90 to 100% of these failures occur in the left-hand rail, and it was suggested that on double track this might be due to defective drainage in the middle of the track causing the roadbed to be soft and the ballast loose under the ties. Mr. Elliott (N. Y. Central Ry.) remarked that in tests of locomotive counterbalancing made by the Railway Master Mechanics' Association in 1892 the greatest load was found to be on the front left-hand driver of a 4-4-0 engine. The difference was not great, however. He suggested that this matter be taken up again in regard to engines having three driving axles. The committee's investigations and tests of rail joints (not yet completed) indicate that it is very necessary to see to the character of the steel used in any form of joint.

The principal work of the committee is the preparation of standard specifications, and while those adopted tentatively in 1910 have not been followed in any purchases, the differences between these and the specifications of some large railways are not great and are growing less. Speaking for the committee, Mr. Churchill (N. & W. Ry.) remarked that differences between the railway engineers and the rail manufacturers as to specifications are becoming less and less. He gave the manufacturers credit for really trying to improve their work.

Ties.

This committee made a report of progress, but presented several appendices. These included statistics of tie renewals, and information as to the use of steel and concrete ties (supplementing the information given in a previous report). The increasing use of cypress for ties led the committee to make some enquiries as to its service. From the returns of over 20 railways it appears that the life averages from 10 to 12 years, with a range of 4 to 15 years. Another matter dealt with was the abrasion and cutting of ties by the rails. The results of observations indicate that the use of steel flanged tie-plates on tangents and curves will increase the life of ties by one to three years, while at the same time the track will be maintained in better condition and at less cost.

There was very little discussion, but Mr. Wendt (P. & L. E. Ry.) gave the results of maintenance cost of track laid with steel ties and oak ties for 3½ years. From September, 1907, till November, 1908, no surfacing was done; the cost of track labor for this period was $417 per mile per year where wooden ties were used and $28 where steel ties were used. Both pieces of track were again surfaced in November, 1909, and the cost was $95 and $153 respectively. During the next 12 months, however, the wood-tie track was surfaced only once, while the steel-tie track had to be surfaced three times. The respective costs for this last period, therefore, were $128 and $428.

Wood Preservation.

This report presented two conclusions, both of which were adopted: (1) that accurate records of life of ties should be kept on certain specific lengths of track, instead of attempting to keep such records for the entire mileage (from which only very incomplete and unreliable returns can be received); (2) that timbers should be framed before treatment. The first was referred to the Board of Direction for consideration. A paper on this subject was published in Engineering News, Feb. 2, 1911. As to framing timber before treatment this is not always practicable; where treated timber is framed, the parts are usually mopped with creosote oil or asphalt. Mr. McDonald (N., C. & St. L. Ry.) advocated immersion for 20 mins. in hot creosote oil and 20 mins. in cold creosote oil, where the size of the timber permits this. It seemed to be the general opinion that present methods of field treatment in such cases are not satisfactory, and the committee was requested to look into the matter. Mr. W. F. Goltra advocated kiln drying or artificial seasoning of ties as superior to seasoning in open air, being quicker and more effective.

Appendices to the report covered the following subjects: (1) specifications for creosote oil, (2) specifications for piles which are to be treated, (3) descriptions of patented preservative processes, (4) grouping ties for treatment, (5) electrical resistance of treated timber, (6) strength of ties treated with crude oil, (7) the use of track scales in weighing timber at treating plants, (8) statistics of consumption and treatment of ties.

Grading and Inspection of Lumber.

This committee submitted classification, grading and inspection rules and specifications for lumber used in maintenance-of-way work. These follow the lines of similar specifications adopted

by the Master Car Builders' Association and various lumber associations for material to be used in railway car work. The desirability of such uniform specifications is evident, and has been proved by the results of experience with timber for bridge, trestle and car work. Mr. J. H. Waterman (C., B. & Q. Ry.) submitted a letter from the Railway Storekeepers' Association, requesting that the specifications be adopted.

Track.

This report dealt with several subjects. It included specifications for switches and frogs, but stated that it is too early to prepare specifications for manganese-steel in such track work, as there is insufficient information regarding the character and life of this metal. As to special fastenings for attaching rails to treated ties, it reported that experience with these (and even with treated ties) in this country is too limited to permit of conclusions being drawn.

A subcommittee had a long report on spiral transition curves, supplemented by a paper on the length of such curves. This latter aimed to establish a relation between the length of the curve and the elements of radius, superelevation, speed, and rate of rise of train on the outer rail. The committee recommended an increase of 50% in length of transition for minor curves when this will not seriously affect the cost or adversely affect the degree of curve. The 10-chord spiral was recommended also. The report stated that spiral curves need not be used when the superelevation for highest permissible speed does not exceed 2 ins. Prof. Talbot (Univ. of Ill.) moved that this should apply also where the distance between the tangent and the parallel tangent of the offset is less than 0.2 ft., or ¼-in. It is a question whether it will pay to put in a spiral where the track will not be shifted more than ¼-in. from a tangent and circular curve. However, this change was not adopted.

Ballast.

The principal feature of this report was a discussion as to the proper depth of ballast. No conclusions were presented but a table was given to show the practice on various railways. The discussion, however, bore almost exclusively upon the subject of the proper size of stone ballast, and there was the usual wide variation in opinion. The committee recommended ¾-in. to 2½-in. Mr. Morse (A., T. & S. F. Ry.) preferred to raise the maximum to 2¾ ins., while Mr. Meade, of the same road, preferred to reduce it to 1½ ins., on the ground that track cannot be surfaced properly when laid with 2½-in. stone. Some members proposed also to reduce the minimum size to ⅝-in., but it was pointed out that this would not be a commercial product. Further, while this size might be satisfactory with hard trap rock, it would be otherwise with limestone and similar material that is liable to pulverize under load.

The committee had specified also that the stone should pass "in any position" through a 2½-in. ring. This was considered to be an impracticable requirement, while if enforced it would mean the use of 1½-in. stone. Mr. M. L. Byers (Mo. Pac. Ry.) has had experience in reballasting track laid originally with stone of such size that it seemed the only requirement was that it should go between the ties. Such track was very hard to maintain in surface, but by filling in finer material and raising track so as to get the large stones well below the ties the result was to get a very good track and a solid foundation. Where large stone is laid in reballasting, it should be distributed and track first brought to within 1 in. of final grade. Then a top layer of finer material should be distributed to complete the surfacing. It was suggested also that the committee should determine the proportions of stone of different size in the ballast.

Fences, Crossings and Signs.

As a result of careful and continued investigations as to means of obtaining fence wire that will resist corrosion, this committee finds that no new process offers any advantage over the old, and that the applied galvanized coating (by special treatment) is the best and only known economical process for protecting fence wire against corrosion. The committee recommends the use of wire which has received a special galvanized coating to stand four one-minute immersions in the standard copper-sulphate solution. The galvanizing to be done preferably after weaving. Concrete posts were recommended for railway fences. By request of the committee the report was referred back to it in order that it might be made more complete for next year.

Water Service.

The committee recommend specifications for wooden and steel water tanks, and submitted tentative specifications for reinforced-concrete tanks. The subject of track tanks was dealt with very fully in an appendix; this included a discussion of the action of the tender scoop in taking water. The specifications for wooden tanks were discussed at considerable length, the discussion including criticisms of several features. The hoops are specified to be round, half-round or half-oval; some members considered that flat hoops should be included, but a motion to make this change was lost. Last year the committee submitted specifications in skeleton form, and was requested to make them more specific; this year it was criticised as being too specific. Eventually the specifications (modified in several respects) were accepted as information.

Signals and Interlocking.

This committee submitted specifications for insulated signal wire, aerial and underground cables, copper and iron line wire, copper-clad steel line wire, and iron bond wire. These were accepted without discussion. In answer to an inquiry as to what has been done in regard to the subject of uniform signal practice, it was stated that nothing can be done by this association until the subject is reported upon by the American Railway Association committee which now has it under consideration.

Yards and Terminals.

This report dealt mainly with the important features to be considered in the design of passenger stations of medium size, including particularly the track layout and the facilities for handling passengers and baggage. General plans were submitted for through and terminal stations, with tabulated information as to a number of existing stations. Other matters discussed were (1) the mechanical handling of freight, baggage and mails, and (2) the provision of special yards for interchange freight. It was recommended that at stations where large quantities of baggage are handled, this should be done at a level below or above the train floor. This was objected to by Mr. Courtenay (L. & N. Ry.) who thought this would apply only to stations of the largest size. In reply, it was pointed out that at many places where grades are not already separated there is increasing demand for separating the grade of tracks and streets. In such revision, it is desirable to include the removal of baggage handling from the train platforms. Of 26 stations listed by the committee 13 are either above or below the steel level.

The committee recommended also that in planning passenger terminals, provision should be made for economical and efficient operation during the periods of activity which may be experienced within a period of ten years. It was voted to change this to 20 years, although the committee pointed out that it would be very difficult to foresee the traffic developments of 20 years, and that such provision might involve apparently extravagant first cost. Mr. Kittredge (N. Y. Central Ry.) thought that a 10-year plan would be outgrown before its completion, and referred to the way in which traffic increase has continually overtaken the several enlargements of the Grand Central Station, in New York. Mr. Temple (Pennsylvania Ry.) said that at the Broad St. station, in Philadelphia, the business increases 50% every 10 years; for 30 years the company has been enlarging the station every 10 years, and is now again facing the problem.

In regard to mechanical handling of freight, Mr. T. L. Condron (Chicago) referred to a terminal freight station now being built in which the freight will be handled by an electric telpherage system. The building is 240 × 400 ft., with 12 tracks on the lower floor and the te... drive-ways and platforms (at right angle... to the tracks) on the upper floor. A series of ...erhead runways on the upper floor (which is 34 ... high) will carry traveling trolley hoists w... h will handle packages or trucks between ... team platforms and the car platforms. N...merous hatchways are provided in the former pl...forms. Mr. W. A. Thompson (B. & O. Ry.) st...d that a pier of the Baltimore & Ohio Ry. at ...ltimore is equipped with the Sprague telpherag... system.

Economics of Railway Locati...

The report of this committee was to ... effect that it has not been able to obtain th... etailed operating statistics which are necessar... or proceeding with its work in regard to the ...nomics of line and grade revision. It has p...ared a statement of the information desired, ... it is for the railways to undertake the time ... ex-pense of preparing this if they desire ... benefit by the work proposed by the commit... Mr. Kittredge (N. Y. Central Ry.) stated t... in regard to operating results many railwa... know that grade reductions, etc., do prod... very substantial economy, but they have not ... cannot get) the detailed analysis of such r...lts, as desired by the committee. Mr. Begier (... & O. Ry.) referred to experiments showing that the train resistance at very low speeds (below 5 m. p. h.) is exceptionally high. This has been the experience in starting heavy trains out of yards, and as a result some $60,000 have been spent in reducing grade at two yards to enable trains to start readily. No action was taken upon this report.

Electricity.

This is a new committee appointed to investigate matters relating to the track equipment, etc., of steam railways having electrically operated sections. The principal part of its report related to the clearance limits between car equipment and track equipment on third-rail lines. These limits were shown for several steam and interurban railways (the latter handling steam-railway cars). The maintenance of track (including organization and methods), the protection of metal structures, the protection of the third-rail, and the connections employed at switches and drawbridges, were among the other subjects touched upon. There was also an extended bibliography of reports and papers on electric traction. The plan of organization for maintenance recommended that this work should be in the hands of the regular maintenance-of-way department. There were a few remarks as to the proper determination of the gage of the third-rail, and also as to the proposed organization for maintenance, but further than this there was no discussion.

Iron and Steel Structures.

This committee submitted specifications for the erection of railway bridges. It made the suggestions (1) that someone be employed to collate reports of special interest on subjects connected with the design and maintenance of steel bridges, and (2) that a study of the design of large steel columns be taken up. A subcommittee report the results of impact tests on long truss spans of the Baltimore & Ohio Ry. bridge at Havre de Grace, Md.; these do not appear to modify the conclusions presented in a former report. No work has been done in tests for impact on short spans, but special apparatus is being designed for these tests as well as for tests of secondary stresses.

There was an extended discussion of the specifications for bridge erection. Several clauses were discussed and modified, and eventually the specifications were referred back for further consideration. A clause requiring the contractor to check the engineer's measurements was objected to by some, while others approved it as tending to provide against possible trouble in fitting the superstructure to the masonry. As a rule the engineer who has established the line and levels is not on the work during erection, and it has happened in several cases that the steel work proved too long to fit the masonry. Mr. Loweth (C., M. & St. P. Ry.) thought that the specifications should permit the use of sheet

lead under bed plates, but the committee explained that after due consideration it had decided against this practice. Its specifications require the use of cement grout or mortar or rust cement. Much of the discussion dealt with clauses concerning the relations between the railway company and the contractor.

Wooden Bridges and Trestles.

The report dealt with various aspects of piling, including wood and concrete piles, sheet piling, pile driving, pile drivers, and pile protection. As to this last question it was concluded that an effective protection against wood borers is afforded by filling sand between the pile and vitrified clay pipe extend from 12 or 24 ins. below to the same distance above mud line; owing to the expense, this method is warranted only for treated piles.

The subject of pile driving is one of very general interest and experience, and the committee's statement of principles of practice for this work received considerable discussion. A good part of this related to the proper methods of using the water jet. Mr. Courtenay (L. & N. Ry.) did not think it would be economical to use this for boring holes in clay soil, previous to selling the piles; he had used it in this way in exceptional cases to enable 70-ft. piles to be set in the leads of a 50-ft. pile driver. Mr. Steffen (Bos. & Albany Ry.) spoke of using a clay auger to loosen the ground and facilitate the driving of piles in hard soil. Mr. Courtenay was of opinion that the jet pipe should be attached to the pile, especially for work in deep water, but Prof. Jacoby (Cornell Univ.) thought that in several there is more difficulty of the pipe clogging when it forms a part of the pile. The tendency of present practice is to use the jet pipe separately. The questions of sharpening the points and using pile shoes were discussed also. Mr. Mc Nab (Grand Trunk Ry.) objected to the committee's suggested use of a cap in driving, but Prof. Jacoby remarked that the advantages of this detail are not sufficiently well-appreciated. He referred to a case where long yellow-pine piles could not be driven without injury unless a cap was used. Mr. Stevens (Ph. & Read. Ry.) had had similar experience, using caps of soft wood; if these were not used, the piles would split, in spite of the usual rings.

Masonry.

A prominent feature of this report was its discussion and analysis of different methods of waterproofing concrete. A large amount of information was presented, including the description of methods used on a number of individual structures, but the information was not of such a character as to warrant any definite conclusions. Other matters briefly considered were the use of reinforced-concrete trestles and the ability of monolithic concrete masonry to resist failure under various conditions.

The discussions related almost entirely to the merits of wood and concrete trestles, and it was stated that if the cost of creosoted timber trestles is capitalized it does not compare favorably with that of reinforced-concrete trestles. On the Illinois Central Ry. several thousand feet of creosoted trestles were burned last year, in spite of the fact that they had ballasted floors. This timber does not take fire readily, but when the fire is well started it becomes uncontrollable. On the Chicago, Milwaukee & Puget Sound Ry. all decks of timber structures are protected by metal or ballast, and the cost of such fire protection must be taken into account in a comparison of costs. The Nashville, Chattanooga & St. Paul Ry. uses galvanized metal covering over the stringers and caps at a cost of 50 cts. per ft. of structure. The metal will last from 3 years on main track to 6 years on branches, but it is expected that the new so-called pure iron will last for an average of 7 years. Stringers protected in this way show practically no decay after many years service.

A comparison of cost was made by one member as follows: (1) for a timber trestle costing $8 per ft. maintenance, 75 cts.; fire losses, 5 cts.; interest ($8 at 5%), 40 cts.; total, $1.20. (2) For a reinforced-concrete trestle costing $30 per ft.; interest charges, $1.50; track maintenance, 20 cts.; total, $1.70.

Buildings.

The special feature of this report was an extended discussion of roof coverings for railway structures, with their respective merits, and their relation to the fire protection question. There were submitted also papers dealing with the work of the Underwriters Laboratories and on fire tests of roof coverings at these laboratories.

Uniform General Contract Forms.

This special committee submitted a form of agreement and contract. The first is a two-page sheet or folder having the introductory statement on one page and the space for signatures on the other page. This alone will suffice for small or unimportant contracts, but for more important work the contract can be enclosed and thus made a part of the agreement. Specifications also may be enclosed, or they may be attached to the outside.

Rules and Organization.

This committee recommended some changes in the general rules for track employees. It presented also an interesting compilation of the rules of different railways covering certain specific matters (ballast, ballasting, track drainage, loading cars, care of signal batteries, etc.); for each subject the committee gave its own suggested rule. Beyond a few suggestions as to verbal changes there was no discussion.

Records and Accounts.

This committee submitted proposed standard forms for (1) sidetrack records, (2) bridge estimates, (3) building service estimates, and (4) water service estimates. One object of the first of these is to give to the officers having charge of maintaining and changing sidetracks information as to the conditions of maintenance; this is especially valuable where the tracks are owned in part by private parties or corporations who are charged with a proportion of the cost of the maintenance work done by the railway.

Brine Droppings From Refrigerator Cars.

This special committee reported that the Master Car Builders Association has approved the recommendations of its own committee acting jointly with this committee and has made its report to the American Railway Association. The American Railway Engineering Association therefore should request the American Railway Association to adopt the recommendations, and should request the maintenance-of-way departments of the railways to provide the facilities recommended. The plan provides for retaining all salt water in the ice tanks, and for draining these tanks only at icing stations. These stations must be provided with facilities for the disposal of the brine thus drained from the cars. The report was adopted and the committee discharged with thanks for the completion of its work.

Conservation of Natural Resources.

This report reviewed the conservation movement undertaken by the federal government in connection with various technical and commercial organizations. It gave also the resolutions in regard to fire protection of forests and protection of timber resources in general, which were adopted by the Lake States Forest Fire Conference as a result of the very serious forest fires of last year.

Exhibition of Railway Appliances.

A large exhibition of railway material and appliances was displayed at the Coliseum, in connection with this convention. Signals made up a good proportion of the exhibits. There were also numerous devices of switches and frogs; many of the latter use manganese steel in their construction, while some were solid castings of this steel. Two designs of track crossings were shown which are designated to give an unbroken rail for whichever track the signals give right of way. Several forms of steel and concrete ties were shown, and also a track construction on longitudinal concrete stringers, and as was suggested in Engineering News some years ago (Jan. 5, 1899). Track fastenings, joints, fences, cattleguards, coaling and water station equipment, bridges, pile drivers, railway ditchers, culverts, steel and concrete piles, roofing materials, turntable tractors, and a variety of other devices and material were included.

The Relation of the Intake Conduit to the Purity of Lake Water.*

By CHARLES B. BURDICK.†

There is no better municipal water supply than that furnished by the Great Lakes, if drawn at such location that it is free from shore pollution. The water in its natural state is clear, tasteless, and odorless, and in mineralization it is the lowest of our western water supplies.

It is commonly supposed that cities upon the lake shores are blessed with a pure and abundant water supply cheaply obtained. This is not entirely true. Experience has demonstrated that (not considering pollution) intake pipes of considerable length are required in order to maintain a continuity of draft owing to the action of ice and the movement of sand. This is particularly objectionable in shallow water. For Lake Michigan, the shallowest water is found generally upon the west shore in the vicinity of Chicago; the depth ranging from 24 ft. at one mile to about 40 ft. at four miles. At most of the other cities between Waukegan (on the west) and Manistee (on the east coast) depths of 25 to 40 ft. are available 3,000 ft. from the shore; 35 to 45 ft. at one mile; 40 to 60 ft. at two miles, and 60 to 120 ft. at four miles from shore.

In the smaller cities fed by pipe intakes, the first difficulty is due to the action of sand and ice. The offshore storms in the shallow waters erode the sand bottom rapidly, tending to clog the intakes or cause wear upon the pumps. In winter, the ice, driven by onshore winds, piles in huge windrows, often 10 to 20 ft. above lake level; in shallow water, this ice extends to the bottom and shuts off entirely a water supply drawn close to the shore.

Experience indicates that an intake 2,000 to 3,000 ft. from shore in from 20 to 30 ft. of water is required to furnish a draft reasonably constant. At times even such intakes give trouble both from ice and sand, and although these troubles can be minimized by proper intake structures, they cannot be entirely obviated at a reasonable expense. In the larger supplies, particularly at Chicago, much trouble is experienced by anchor ice as far out as four miles in 40 ft. of water. The trouble from this cause is largely a matter of the total draft in one locality and the velocity of the water as it enters the intake. These conditions make it impracticable for even small cities to draw water at a less distance from shore than from 2,000 to 3,000 ft. The construction of submerged intake pipes is expensive, requiring considerable dredging in depths of less than 20 ft., and therefore in villages and smaller cities it is often less expensive to secure well-water than to draw water from the lake.

TURBIDITY.—Throughout the majority of the year the water is clear, even when drawn close to the shore. In rough weather it is quite turbid near the shore, and under certain conditions this turbidity may extend for several miles into the lake. The lake bed, at least as far out as the water works inlets, is clay. Adjoining the shores, the clay is overlaid with more or less sand, ranging in depth from about 20 ft. at the shore line at Chicago to 40 ft. at Gary. In certain places it extends into the lake from one to two miles. At certain other places, particularly along the west shore, the sand is almost entirely lacking. The action of the lake storms tends to erode the clay bottom and to pick up the sediment discharged at the river mouths. This results in a decidedly turbid water at many of the Chicago suburban towns, and is quite noticeable in the water supplied to Chicago in time of severe storm. This trouble is apparently most frequent with intake pipes of 1,500 to 3,000 ft. It is of least significance at Chicago, where water is drawn two to four miles from shore, although the lake bottom at these points is doubtless quite dirty from the dredge dumpings and the sediment discharged by the sewers prior to the opening of the drainage canal.

It is generally believed that in depths exceeding 40 ft. the influence of wave action is insufficient to cause serious washing and consequent turbidity. However, the distance of the intake from the shore has also a bearing upon this matter. In the off-shore storms, which cause the most serious cutting, the travel of the surface water is shoreward, with an undertow outward. The turbidity caused by sediment and clay is extremely fine, and waters containing these substances require many days to regain their clearness. Under these circumstances the turbidity developed in the shallow water is transmitted to the deeper waters in the same manner that the shore pollution reaches off-shore intakes.

LOCATION FROM SANITARY STANDPOINT.—It is not sufficient that a water be clear, tasteless, and odor-

*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, at the University of Illinois, Feb. 21, 1911.

†Hydraulic and Sanitary Engineer, 1212 Hartford Building, Chicago.

less; the foremost consideration is the freedom from sewage contamination. The matter of expense makes necessary the drawing of a municipal water supply close to the town, and the problem of pure water is therefore complicated by the common practice of discharging sewage into the lake. Several investigations have shown that the effects of a relatively small sewage pollution may be traced several miles from the point of its entrance to the lake under certain conditions.

Experiments have shown that the typhoid bacillus may exist in comparatively pure water from 3 to 40 days, dependent upon the local circumstances, the character of the water and the temperature. Under these circumstances it is surprising that the results from using lake water drawn in proximity to the sewer outlets has not been attended with greater harm in many of our water supplies. The answer is probably to be found in a missing link in the chain of typhoid pollution, rate of travel, direction of current, and possibly some uncertainty as to the virulency of the typhoid bacillus after immersion for a certain time in the lake water. It may lose its virulency before life is extinct. As is the case with turbidity, a good water may be obtained throughout the majority of the year at comparatively small distances from the pollution source, but it is not sufficient that a municipal water supply be pure most of the time.

There has been some study of the currents in Lake Michigan with a view to determining their effect on intake location.* The ordinary current, at least within several miles of shore, is extremely sluggish, and it is undoubtedly the occasional wind-induced currents that do most harm. They are most dangerous when most rapid. This will depend upon the velocity of the wind, and bad consequences are doubtless augmented by the turbulency of the waves in stirring up lake bottom deposits. These facts suggest the desirability, where surface cribs are used (as at Chicago) of so locating intake port openings that water may be drawn near the surface or near the bottom, depending upon the direction of the currents. It seems probable that in most storms this practice would permit a considerable improvement in the character of the water drawn both in purity and clearness.

Cost and Capacity of Long and Short Intakes.

The cost of an intake for a given supply of water increases rapidly with its length. Assuming that there is a certain distance from shore or pollution source, where pure water may always be obtained, it becomes a question as to whether, from a financial standpoint, it is best to construct an intake of sufficient length to secure pure water, or to draw a supply closer to shore and subject the water to purification. To illustrate the importance of more definite knowledge of the distance of pollution travel, the writer gives the relative costs of long intakes as compared with purified supplies drawn from short intakes.

CASE NO. 1.—For a supply of 5,000,000 gals. per day, assume that pure water can be obtained three miles from shore, and that a constant supply can be secured ½-mile from shore. To provide the required quantity of water from a 3-mile intake, a 24-in. pipe will be required, with an expenditure of about $200,000. The cost of securing water from this intake will practically amount to the fixed charges, which we will assume at 5% to cover interest and 2% for depreciation, making a total annual charge of 7%, or $14,000. For the ½-mile intake, a 16-in. pipe is required at a cost of $21,000, and a filter plant at $75,000, making a total of $96,000. Placing the fixed charges on filtration plant and intake at 8%, assuming that the water can be coagulated with alum at not to exceed 1 grain per gal., and including the cost of secondary pumping and chemical supervision, 5,000,000 gals. per day could be purified for about $8.35 per million gallons. This makes the total annual cost $15,200, as compared with $14,000 for a 3-mile intake.

It will be seen that the investment in the short intake and purification works is less than that of the long intake; but that the annual cost, including all charges, is approximately the same in the two cases. If the situation is such that turbidity is not an important factor, the supply from the short intake may be purified by the hypochlorite process (including chemical supervision and fixed charges in the intake) at a total cost of about $3,500, per year, which will pay a fixed charge of 7% on an investment of $50,000. This would cover the cost of an 18-in. pipe one mile in length, capable of furnishing 5,000,000 gals. per day. To summarize: we can filter a supply drawn ½-mile from shore for approximately the same cost as an unfiltered supply drawn three miles from shore; and if the hypochlorite treatment is applicable, a ½-mile intake purified is comparable with a one-mile intake unpurified, the quality of the resulting waters being equal.

CASE NO. 2.—For large supplies of water, the relative merits of the propositions are different, owing to the fact that they require a relatively small expenditure in intakes. Take a case where 100,000,000 gals. per day are required, and assume that pure water may be secured three miles from shore. Compare this proposition with a purified supply secured ½-mile from shore. A supply of this size is beyond the capacity of our largest pipes, and a multiplication of pipes is not economical. The best investment, if underground conditions are at all favorable, lies in a tunnel. A 7-ft. tunnel, three miles in length (in clay), under favorable circumstances can be constructed for about $25 per ft., including shafts, but exclusive of intake crib. This would require an investment of $400,000, which at 6% (the depreciation is small on this type of construction) would involve an annual expenditure for fixed charges of $24,000.

A filtration plant could probably be built to purify this water for about $1,200,000, and a 6-ft. tunnel, ½-mile in length, which is about the smallest that it is practicable to build, would cost about $100,000, making a total expenditure of $1,300,000, which at 8%, produces a fixed charge of $105,000 per year. Such a plant could be operated, including coagulant, secondary pumping, labor, supervision, and ordinary maintenance, for an additional $105,000 per year, making a total cost of $210,000, as compared with $24,000 for the annual cost of a 3-mile intake. The sum required for the filtration of the water will pay 6% interest on an expenditure of about $3,000,000. It will be seen that if filtration is required, very long intakes are warranted for large supplies.

Assuming that the turbidity of the water is such that the hypochlorite process will give a satisfactory supply from a short intake, the conclusions are somewhat different. Including the fixed charges on the intake, and the nominal investment required for the application of the process, the water from the ½-mile intake could be purified for about $22,000 per year, which will pay 6% on an expenditure of only $370,000, a sum sufficient only to build a tunnel about three miles long.

These estimates are not given in the hope that they will solve the problem for any particular locality. Conditions and costs vary so widely that the conclusion applicable in one city may be reversed in another. Their object is to emphasize the fact that there is a relation in the financial value of the pure and purified waters, and that to solve the problem for any locality requires a better knowledge of the sanitary conditions in the lake than is possessed at the present time. Individual and fragmentary analyses are not sufficient. They must cover daily analyses in any locality over a sufficient period to include all conditions of wind and weather. While the conclusions at any particular place do not necessarily solve the problem for all the lake cities, yet they very materially assist in the formation of correct opinions subject to general application.

*Engineering News, Jan. 21, 1909 (p. 78), and Sept. 29, 1910.

The Purpose and Work of the Underwriters' Laboratories.*

By WILLIAM H. MERRILL.†

The Underwriters' Laboratories, Incorpofated, is an institution operating under the direction of the National Board of Fire Underwriters. Its principal offices and testing station are located in Chicago. It has branch offices for the conduct of its business in 32 other cities in the United States and Canada. The Chicago plant occupies a three-story and basement building of fireproof construction containing something over 20,000 sq. ft. of floor space with a frontage of 116 ft. Yard space is provided for huts and large testing furnaces.

The main building is, perhaps, the best example in America of absolutely fireproof construction furnished with fireproof finish and equipment. It has been designed as a model to show a practical solution of many of the problems raised by the enormous and disproportionate loss by fire in the United States. Brick, terra cotta, concrete, stone, steel and iron are exclusively used in the structural features. The window frames and sash are of metal wired glass, the doors are of metal, the desks and filing cases in the main office are of steel, and even some of the picture frames are of the same material. No wood or other combustible material is used in any portion of the finish or equipment. In addition the plant is equipped with automatic sprinklers, and the lighting and heating hazards are safeguarded with every known precaution applicable to their installation in buildings of frame construction. In this case the Underwriters have gone to the extreme in adopting in their own property all of the measures they are known to recommend in the property of others. The Chicago plant employs 45 persons and has a value of approximately $100,000.

The business of this institution is the examination and testing of appliances, devices, systems and materials having a bearing on the fire hazard. These include (1) appliances designed to aid in extinguishing fires, such as automatic sprinklers, pumps, hand fire appliances, hose, hydrants, nozzles, valves, etc.; (2) materials and devices designed to retard the spread of fire, such as structural methods and materials, fire doors and shutters, fire windows, etc.; and (3) machines and fittings which may be instrumental in causing a fire, such as gas and oil appliances, electrical fittings, chemicals and the various appurtenances used in lighting and heating.

Up to the present time the laboratories have examined and issued reports on over 5,000 different appliances, each report representing from one to a dozen series of investigations and experiments. Many of the reports are promulgated on printed sheets according to classifications, and cabinets containing these cards are maintained at the offices of the principal Boards of Underwriters and inspection bureaus in the United States, at many of the general offices of insurance companies, by some insurance firms, certain municipal departments, and at the local offices of the Laboratories. Much of the information is also freely distributed by means of lists of approved and permit devices promulgated by the National Board of Fire Underwriters.

The results of the work in many classes of appliances are furnished directly to building owners, architects, users and all other persons interested by means of the Laboratories' labeling system, under which goods are inspected at factories by Laboratories' engineers and stamps (or labels) attached to such portion of the output as is found constructed in accordance with standard requirements. By means of this service the quality of goods, in factories where approved articles are made, is carefully observed, and the use of labels restricted to such portion of the output as meets in all essentials the standard of efficiency shown by the sample originally tested and on which approval was based.

Experience has shown that this method is in every way superior for the purpose of bringing to the consumer the article he desires, for the purpose of placing competition between manufacturers beyond the point where deterioration in the quality of the output is made necessary, and for the proper protection of the Laboratories and the organization cooperating with them which are giving substantial recognition to efficient fire protection appliances. It is also shown that an inspection and checking system of this nature can be efficiently operated under the Laboratories' direction without calling upon the manufacturer to give undue publicity to his manufacturing process, or subjecting him to any embarrassment or annoyance.

This service, which carries the statement of the Laboratories as a manifest on the goods themselves, is proving itself the best solution yet devised of the many perplexing problems incident to bringing to the consumer the opinion of someone in authority on the merits of devices and materials in respect to the fire hazard. It is safeguarded by competent inspectors at the factories where the goods are turned out; by special agents going from one inspection office to another; by reports carefully scanned by examiners and engineers at the head office; by frequent examinations by Underwriters' inspectors in the localities where they are installed; and by rival manufacturers noting closely the quality of their competitors' wares when labeled.

The consumers' interest in obtaining these expressions through this channel is becoming more and more apparent. No such remarkable growth as the record shows in this branch of the work could have been possible without popular approval. For the year ending March 31, 1910, a total of 16,815,920 labels were supplied inspectors—a noteworthy number when it is considered that the service has been in operation less than five years.

The object of examinations and tests at Underwriters' Laboratories is therefore to bring to the user the one best obtainable opinion on the merits or demerits of an appliance in respect to the fire hazard. That we have accomplished this object in a large measure is obvious to those who have had occasion during recent years to look into the equipments of automatic sprinklers, fire doors and shutters, wired glass windows and their frames, fire-door and fire-window hardware, hand extinguishers, electrical, gasoline and acetylene machines and similar fittings and materials going into buildings, and private fire department apparatus for interior and exterior use. Now we are beginning to take up public department apparatus.

Manufacturers and buyers and users and engineers and experimenters and observers all form opinions, and many of these are often, of course, widely at variance. But among them all there is to be found somewhere a concensus which is correct. And just as we are able to work this out and promulgate it, we are able to serve to the best advantage our clients, the insurance companies and their customers—the assured. Our institution has been organized and developed along these lines. The error of supposing that any one man or any one set of men can be omnipotent in any particular field has never threatened us. Since the inception of the work we have safeguarded our institution against the possibility of hasty, unwise or arbitrary misuse of the authority delegated to us by withholding each conclusion arrived at as the result of Laboratory experimentation until it has received the careful scrutiny and the approval of all the principal men in this country best fitted through field experience and years of training to pass judgment thereon.

*Abstract of an address delivered at the annual convention of the International Association of Fire Engineers, Syracuse, N. Y., August, 1910.

†General Manager, Underwriters' Laboratories, 207 East Ohio St., Chicago.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
REPRESENTATIVES: RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
M. MARUYA & CO., Ltd., TOKYO, JAPAN

GEORGE J. FROST, President
CHARLES WHITING BAKER, Vice-President
FRANCIS J. FROST, Secretary and Treasurer

ALFRED E. KORNFELD, Manager

CHARLES WHITING BAKER, M. N. BAKER, E. E. R. TRATMAN, F. E. SCHMITT, } Editors

SUBSCRIPTIONS

United States and Possessions, Mexico and Cuba, One Year, $5.00.
Canada, One Year; $7.00; Thin Paper Edition, $6.00.
Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00. (£1.18.0.), 45 Francs or 37 Marks.
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $7.00. 29 Shillings, 35 Francs or 29 Marks. Remit directly to our office.
Remit by Post-Office or Express Money Order, Draft on New York or London, or by Registered Letter.
Notice of change of address should reach us one week in advance of removal. The old as well as the new address should be sent.
Subscriptions cannot be dated to commence with past issues.
All subscriptions commence with current issue and back numbers can be supplied only by special order.
Receipt for Subscriptions will not be sent unless requested, the changing of the expiration number being considered sufficient. The number on the address label indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year. Thus 521 means the 52d week or December 28, 1911.

ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See "Want" Pages.

Copy for regular, or "Contract," Advertisements should be received at least ten days before publication; "For Sale" and "Situations Wanted" Advertisements by Monday, and "Proposal" and "Situations Open" Advertisements by 9 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

The ubiquitous unseen fire danger revealed itself in horrible form last Saturday among a busy army of shirt-waist makers working ten stories above ground. The outcome is only less appalling than that of the Iroquois Theater fire in Chicago. In both cases a fireproof building was the setting of the tragedy, and in each case the building justified its name by coming through without much injury. But the lives of the people crowded into the fireproof box were not fireproofed.

Clearly, more is needed than merely incombustible building construction. The dangers of situation and occupancy must be realized and steps taken to eliminate them. The public learned effectively of the fire danger residing in theaters. It has still to acquire similar knowledge of the danger in other buildings—dangers long-since appreciated by those who have studied fires and fire prevention.

The public does not permit powder magazines to be located in the heart of a city or where many lives would be endangered. But it does permit great aggregations of easily inflammable combustibles to be placed anywhere, even in a tall building crowded with workers. It tacitly approves wholesale gambling against the chances of a fire outbreak. Neither law nor administrative practice nor public sentiment decrees anything to prevent factories, warerooms and stores from being so located and grouped and so packed with human beings that every available resource of rescue and fire-fighting work is powerless to help when the fire chance wins.

The Harris & Blanck shirtwaist factory was inspected by the State factory inspectors within two months and reported to be substantially up to the law. The building was inspected by the city Fire Department six months ago and reported good. The municipal Bureau of Buildings had approved of its construction and, while some departures from the letter of the law are admitted, yet in the important points the design and construction complied with the requirements. No law stepped in to say that three superimposed quarter-acres filled with cuttings of flimsy fabric contain a grave fire risk; not even to the extent of saying that here, if anywhere, the protective aid of automatic sprinklers is needed. No law said that 700 persons on the three floors, ranged in among tables, sewing-machines, boxes and piles of goods, are too many for safe and rapid exit; or that subdivision into smaller compartments is needed to reduce the risk. The gravity of the conditions is not fairly measured by the death-roll. Had there been seven floors above the shirt-waist factory as there were seven below, not merely three floors but ten would have furnished victims.

We have now the lesson of a loft-building factory fire. The thousands of similar factories, many of them presenting even worse conditions, will now be gone over with an eye to safety, and there may be new legislation on such factories. Other dangers equally imminent are likely to escape public notice until they have their own disaster as a lesson. A great department-store fire is perhaps still in store for us to demonstrate, before the eyes of all, the fire dangers lurking in those establishments. The fire department officials of New York City have long been apprehensive even of a fire calamity in one of the office-building skyscrapers.

It is urged now that a municipal bureau of fire prevention be established. There has hitherto been no centralized effort in the direction of fire prevention with special view to safety, and much of the present protective legislation is virtually nullified by the splitting up of its enforcement among three or four separate state and city departments. Something would be gained in the proposed new supervisory organ, without question. But there is also something to be lost, namely, the responsibility now resting on owner and employer to make his premises safe regardless of specific law. With such a bureau the owner would be freed from all responsibility except compliance with particular laws and instructions. But fire-prevention safeguards cannot be reduced to dry rules, and the unfortunate result would be to shift the whole blame for any future Triangle Waist disaster from the owner to the bureau. What is most urgently needed is to place *more* responsibility on owner and employer rather than less.

While the public obligations of railways and other public-utility corporations are now pretty well recognized, some persons are inclined to take a very narrow view of these obligations. A case in point appears in a recent newspaper editorial. The article interprets the requirement of rate regulation, that rates must be just and reasonable, in a peculiarly restricted sense, namely in the sense that "just and reasonable" refers only to direct income from a given class of service as compared with the cost of that service. Applying this view to commutation rates, the newspaper says that, since these rates are lower than regular rates, and since "no railroad company would commit the folly of increasing a commutation rate to a point above the regular rate," therefore the commutation rates

are something wholly voluntary with the companies. They may withdraw them altogether any time they see fit.

The conclusion is also drawn that under the circumstances no rate-regulating body could have any power over commutation rates. Of course this argument in the first place assumes that suburban commutation business is done at a loss, which has never yet been shown. But quite aside from this, it is obvious that changes of rate are inherently bad business practice, and that commutation service particularly involves a certain obligation on the railway to maintain service and rates until compelling reasons for a change arise. Railway rate regulation, if it is to be of use to the community, not only may but must take account of such elements of the situation. Regulation by public authorities bases on much broader considerations than merely those of direct income, and it calls for constant application of common sense and decent business principle.

Nearly all of our more progressive state boards of health now have an engineering department, so it is not at all surprising to learn that an effort toward the establishment of such a department is being made in California. The board of health of that state, it appears, already has an engineer-inspector in the person of Mr. Ned Baker. In the Monthly Bulletin of the California State Board of Health for December, 1910, there is a brief article by Mr. Baker on the proposed Engineering Department for the State Board of Health. The author concludes by the following statement of work that might well be undertaken by such a department:

Such a department should make some experiments on sewage disposal under California conditions, so that new works in the state need not be designed purely on theory, as has been the case in some instances where they were the first of their kind. Experiments in Massachusetts, and elsewhere, do not apply to California climate and conditions in many cases. Even if they did, the results of local experiments would be given more weight by local engineers than those made elsewhere.

This department should also make a study of existing plants in the state, to determine how the features of their design and operation affect their efficiency. Such a study, much more extensive than the one planned here, was made in Ohio in 1907 and 1908, with very gratifying results.

It is probable that the passing on plans for new works would not be one of the least duties of the proposed new department. This is desirable for several reasons—to insure that the method adopted is the one best suited to the case, to prevent the carrying out of plans that might endanger the health of the community building the works, or the health of other communities, and to insure the building of works that are planned to be economical and efficient.

In conclusion, it should be said that such a department, to be effective, must be an integral part of the State Board of Health organization, and must be independent of other state departments. Any arrangement to regularly refer questions of this sort to an engineering authority outside the jurisdiction of the Board, would be as unwieldy as it would be unsatisfactory. The people of the state look to the State Board of Health for advice, in matters pertaining to public health. The safeguarding of water supplies, the disposal of sewage, and sanitary engineering in general, are so inextricably mixed up with public health questions, and with the Board of Health work, that to try to separate them is well-nigh impossible—and altogether undesirable. In order to intelligently, and helpfully, answer the questions that will come before it, the California State Board of Health is in need, not of men trained in general engineering practice, but of men specially trained in biology, and that branch of engineering that has for its object the safeguarding and preserving of public health.

The foregoing statement seems to put the case strongly and fairly. The general argument presented, with modifications to suit differing conditions in other commonwealths, applies with equal force to other states of the Union, which as yet have no adequate engineering departments connected with their state boards of health.

How does the work of engineering research and experimental investigation benefit the general public? This is a question that may be answered easily and in a manner calculated to convince the most skeptical. But it is a question which crops up from time to time, especially when engineering colleges and similar institutions apply to legislatures for financial aid in carrying on and extending their work. The objection is apt to be made that the work is to benefit engineers, as a distinct class, and therefore does not deserve to be made a public charge. If it is urged, in answer to this, that the work does actually benefit manufacturing, transportation and other interests, it may still be objected that public funds should not be furnished for the benefit of even such interests. In such cases it is necessary to show conclusively that the work does really benefit the public at large and is a matter of general public concern. This subject has been dealt with recently by Dr. W. F. M. Goss, of the University of Illinois (Dean of the College of Engineering), in a paper read before the Western Society of Engineers. His paper related more particularly to the engineering experiment station at his own university; but its showing as to the relation of the work of such an institution to the welfare of the general public is of universal application.

Apart from the strictly technical features of its work, one of the functions of the Experiment Station is to furnish information of value to manufacturing, mining, transportation and other interests. The service which it may render to any one plant tends to increase the efficiency and stability of the establishment, to improve the product, and consequently to give increased security to its employees. It tends also to an elevation in the character of the work and of the employees. Thus the service of the Station will ultimately affect favorably that part of the population which derives its support from this industry. Furthermore, whatever benefits the manufacturer in this way tends also to benefit

his patrons and the general public by better products, larger output and lower prices. If the Experiment Station should be able to show to the mine owners and the mine workers how waste may be reduced, output per man increased, and greater safety ensured, the immediate benefit of such improved methods would be to those connected with and dependent upon the business of mining. But the wider ultimate effect would be towards reducing or keeping down the price of coal, to the benefit of coal consumers in general. In transportation, also, whatever contributes to better efficiency tends to result in increased safety, comfort or convenience of the traveling public, in quicker and better freight transportation facilities or in reduced cost of service. Thus, to quote Dr. Goss:

> Any industry to which the Engineering Experiment Station of the University of Illinois makes a contribution in the form of a scientific fact becomes of necessity a distributing agent through which the fact is made serviceable to the public; and as a consequence, the Station, through the exercise of its legitimate functions, makes a contribution to the life and the welfare of all classes of people.

Obviously, there is seldom if ever warrant for carrying state research work so far that it will be of service only to a single manufacturer or company. Under wise administration, there is little danger of this. In fact, even though through lack of wisdom there should be willingness to go too far in this direction the demands for experimental studies of wide usefulness are likely to be so many that only by wilful perversion of a public trust are the public funds likely to be used solely for private benefit.

What is the Condition of the American Street Railway Industry?

On the appearance of Mr. Bion J. Arnold's report on Pittsburg traction troubles[1], we briefly noted[2] his method of making a quicker diagnosis of transportation troubles of street-railway companies than would be arrived at through an engineering and economic study of them as "going concerns." The four prominent features of this method of study were found to be: (1) An investigation of how the systems might be operating in conflict with recognized engineering and economic principles; (2) a comparison of the companies' latest and previous operating records; (3) a comparison of the locality in question with similar localities in general growth and development of business; (4) a comparison of the companies' operation with the records of concerns doing business in these similar districts. In our issues of March 2 and 9, we reprinted portions of a recent Interstate Commerce Commission report on advances in freight rates in which the Commission necessarily based its ruling, against increases, on studies which are somewhat superficial compared with an evaluation and detailed analysis—such as (1) comparisons of railroad and municipal bonds, (2) comparison of railway earnings, past and present, with current interest rates, (3) relations between operating costs and gross revenue (4) relations between credit and invested surplus.

We reprinted these discussions believing that the methods of study disclosed, if carefully safeguarded, would be interesting and broadly useful in specific instances. Now it almost seems as if successful approach to public service problems by such admittedly superficial studies had encouraged less skilled hands similarly to back up claims whose truth is not easily proven, or to make sweeping recommendations for real or fancied ills. It seems advisable, then, to give a word of warning against proposing remedies after studying one or two prominent symptoms to the neglect of less apparent but possibly more important evidence, and against drawing too positive and too broad conclusions from meager evidence.

In reading the January "Annals of the American Academy of Political and Social Science."[3] we found a strangely pessimistic paper entitled, "The Decreasing Financial Returns upon Urban Street Railway Properties," written by Dr. Thomas Conway, Jr., Assistant Professor of Finance, Wharton School of Finance, University of Pennsylvania. This paper seems to illustrate the dangers just mentioned, incident to generalizations based on a limited range of surface inquiries. The paper also seems to illustrate the need of knowing just how far one must go in any analysis before it becomes safe to base conclusions upon that resulting data. We are moved to call attention to certain parts of this paper because the "Annals" seem likely to have a considerable circulation among public-utility officials and engineers. Prof. Conway's ideas also correspond quite well to some which have been advanced by interested persons who find it easier to demand greater gross return from the public than to turn their thoughts inward to possible economies and to the correction of early mistakes.

Prof. Conway asserts that the urban-railway industry at the present time is facing a financial crisis since

> for some years it has been evident that the net earnings have been decreasing or stationary rather than increasing.

He attributes this to (1) decreased average earning per rider, and (2) the "widespread, persistent and alarming" increase in cost of maintenance and operation. As a result, the author naively remarks that

> the companies are, therefore, caught between two dilemmas, (*sic*) both of which work to the same end.

The first of these ideas is expanded later on in this way:

> Two effects stand out, however, as indisputable: First, that the street railway companies through the operation of the transfer are suffering a rapid and alarming decline in the rate of fare per passenger carried, which, unless checked, will bring financial disaster; and, second, that the first step in finding a solution of the difficulty is the education of the public to the nature, extent and effect of the transfer problem in order that their cooperation may be secured in working out a satisfactory solution.

With these assertions we disagree since (1) a survey of the industry does not show that a crisis is impending in the affairs of a sufficient number of companies to menace the whole industry, (2) most of the individual companies in distress can trace their shortages to worse troubles than mere decreased average fares, and (3) the marked decrease of the ratio of operating expenses to gross income, in many notable instances, hardly points to a necessarily "alarming" increase in all operating expenses.

We believe that impending disaster cannot safely be prophesied from mere "decreased average return per rider" and average "increase in cost of maintenance and operation" of all the properties in the country lumped together. We do not feel that the transfer, or even the present existing abuse of transfer privileges, should have to carry so much blame. It is admitted at one or two points in Prof. Conway's paper that complete abolition of the transfer would disorganize the railways and disturb the distribution of urban populations, and that well-planned routes with transfers tend to yield an economical traffic density. Such admissions are carefully qualified, however, as in the assertion

> that drastic steps must be taken to limit the growth in the transfer habit, in order that the company may be in possession of sufficient revenue to meet its expenses.

The cry is always for revenue, more revenue, without due regard, we think, for public convenience, toward increasing public confidence or to what constitutes an unreasonable journey for one fare.

The paper under scrutiny brings out a few questions such as the following, some of which have an obvious answer: (1) Are the street railways generally facing a crisis or are a few properties involved in trouble because of early mistakes and present mismanagement? (2) Ought net earnings and dividend rates to be expected to climb continually as the electric-railway industry settles down into a more stable position and under the spreading protection of public regulation? (3) Does an increasing ratio of operating expense to gross income mean disaster or is it the expected accompaniment of greater use of (and return from) actual investment?

In searching out adequate grounds for an opinion on the condition of American electric railways it would seem wise to go behind the quoted averages and to look first of all at the actual capitalization, earnings and ex[illegible] specific properties scattered about the [illegible] We have done this and in the accompa[illegible] ble typical results are shown for each [illegible] interpretation. The 25 companies the[illegible] have been taken quite at random from [illegible] of medium-sized properties of which [illegible] data have been published.[4]

These figures show such diversity that [illegible] conclusions are to be very cautiously d[illegible] financial crisis, however, is not clearly s[illegible] the 25 concerns noted, 21 were pay[illegible] dends according to latest reports. Only [illegible] very recently discarded dividends or dec[illegible] rate and 21 *of the 25 were paying more than ten years ago.* Peculiarities of cap[illegible] or operation are shown in most of the n[illegible] properties, which are not appreciably [illegible] than they were ten years ago.

There is a general tendency to increas[illegible] the ratio of operating costs to gross income [illegible] what it was many years ago, but there is al[illegible] seen a tendency in the latest figures to impr[illegible] upon those for one, two or three years previo[illegible] This indicates, perhaps, that the cost of su[illegible]s has diminished or that economies have been [illegible] and to offset increased cost of materials and l[illegible] This view is also confirmed by the recent d[illegible]ion of the Interstate Commerce Commission in [illegible] case of Eastern railway rate advances, [illegible]herein Commissioner Prouty found that the [illegible] general cost of railway supplies is now lower than for the past five years, and that labor is not apt to go higher.

It is seen, of course, that many street-railway properties about the country have great need of improvement, but there are so many [illegible]parallel cases of paying properties that, until better analysis shows differently, we must conclude that this desired improvement might come from individual housecleaning as well as from a general boosting of gross revenue all over the country for present service.

Not satisfied with a study of these larger systems alone, we made a random selection of 25 *small* companies in different parts of the country for similar scrutiny. The data for these have not been tabulated here. In 10 cases there was a marked increase of operating ratio and in 15 a decrease, usually small but often marked. Generally, there was also the expected rise during the panic period. There were 14 properties which earned 4% or more above operating and fixed charges; 13 showed a persisting increase in such net earnings, while none showed a decrease and only three carried a deficit, and those not of very recent origin.

In seeking to understand the grounds for Prof. Conway's calamity forecasts, we have examined his references to the New York, Boston and Chicago situations. One runs thus:

> On Sept. 24, 1907, however, the New York City Ry. Co., the lessee of the Metropolitan Street Ry. Co., had been forced into bankruptcy. The receivership was extended to the Metropolitan Co. on Oct. 1, 1907. There can be no doubt that the financial embarrassment of these companies was largely the result of the heavy decline in the average rate of fare through the operation of the transfer system. Illustrations might be multiplied indefinitely. It is generally conceded, however, that the same development has occurred in every large city in the country.

Figures were also presented to show that the average fare per passenger on the surface lines of New York city had declined from 4.94 to 3.09 cts. between 1888 and 1908. Also as

> conclusive proof of the accuracy of the diagnosis which credited a considerable share of the financial misfortunes of the company to the transfer system

it is stated that curtailing of transfers has brought up the fare to 3.40 cts. again and placed the system on a better basis. (The fact is seemingly passed over that this restoration of average rate of fare is only to that existing late in 1906 or early in 1907, at which time the company was already in its serious difficulties.)

In view of certain disclosures of the clever manipulation of the artistic capital structure of the once consolidated surface lines in New York City, this is a very positive statement, particularly from a teacher in a public institution like the University of Pennsylvania. We have previously noted[5] how corporate relationships had

[1] Reprinted in Eng. News, Feb. 9 and 16, 1911.
[2] Eng. News, Feb. 9, 1911, p. 169.
[3] Reviewed in Eng. News, March 16, 1911, p. 38, of Engineering Literature Supplement.
[4] "American Street Railway Investments, 1910."
[5] See Eng. News, Oct. 3, 1907, p. 363; and March 5, 1908, p. 264.

been entangled and interwoven, and how capitalization had been piled up and honeycombed until the company was forced into bankruptcy by the burden of fixed charges on non-existent property. For instance, the $120,000,000 supposed to lie in some 516 miles of track, of which 300 miles was of very simple construction. Now, a professor "discovers" that the trouble was caused by the public itself in its greed for cheap transportation.

To predict disaster for a whole industry because the ratio of transfer passengers to revenue passengers in New York has increased, say from 1% to 55% in 20 years, or because the average fare per passenger in this city has declined from 4.94 to 3.09 cts. in the same time, is entirely too superficial. At least we can ask how the reduction in revenue per car mile, or per passenger mile, compares with similar units of operating expense and investment in the case of a considerable number of other companies.

Prof. Conway also makes much out of the statement that out of each fare collected on the Chicago City Ry. only 0.42-ct. remains for division as profit between the city and stockholders of the company. The important fact is neglected that this is 14.2% of the fare and that in 1910 a dividend of 9% on stock was declared and a sum equal to 0.435% of the stock was deferred as surplus—all this with an average passenger earning of 2.95 cts., and in spite of fears that

a most serious defect in the franchise system in Chicago in 1907, in the opinion of many well informed persons, is the clause imposing upon the company the duty of giving universal free transfers.

The situation of the Boston Elevated Ry. Co. is cited in this connection with the statement that only 0.29-ct. or 5.8% of each nickel represents profit out of which dividends can be paid. Instead of relying on this view alone, it would also have been interesting and helpful to know that this was 9.2% of the average fare and that out of such margins the company has paid its stockholders 6% dividends since 1902 and that in 1909, much as in previous years, the equivalent of 1.16% on stock was deferred as surplus, giving a total annual earning of 7.16%. This, of course, is not large for a speculative venture, but it is a fair return if we consider that its income is practically assured by wise public regulation so long as the company maintains good service. Indeed, the company is more optimistic than Prof. Conway, if its sinking of $55,480,000 in the last 12 years and its desire to sink $31,173,000 in a few years more[6] into improvements and extensions is good evidence.

Mention is made of agitations for 3-ct. fares with the statement that the desired result has been in reality secured by the operation of the transfer system. It is therefore interesting to note the eagerness with which bonds of the Cleveland Ry. Co. were seized by the investing public a few weeks ago. One banker reported at this time that these bonds were the strongest public-utility bonds in the country, and this in spite of the peculiar franchise conditions in Cleveland, which now enforce a 3-ct. fare with 1 ct. for transfer, giving an average of 3.17 cts. per passenger.[7] This company had a net income in 1909 of $1,787,278, which was a 12.2% return on its capital of $14,675,600, although this total income was deferred as a surplus.

Prof. Conway's remedy for the troubles of street railway concerns arising from the obnoxious transfer situation involves reducing the fare for a single ride to 4 cts., with 1 ct. for the transfer. He believes that the reduction in the straight fare will be offset by the gain through the sale of the transfer. It is hard to understand how this would be accomplished, considering the basis of fare to be 5 cts. Under the old scheme, every first passenger would pay 5 cts. By the proposed scheme most of the first passengers would pay 4 cts., and a few of them taking transfers would pay a total of 5 cts. The effect of a general reduction of fares in stimulating travel, or the effect of sale of tickets in facilitating loading of cars, is not to be confused here with the study of the transfer situation.

Increased cost of operation is touched on in his paper, but mostly in gross rather than useful unit figures and ratios. It is stated that the operation of urban railways from 1902-7 shows that the percentage ratio of operating expenses to operating earnings has increased from 57.7 to 60.1%, and in the case of the large companies having a capitalization of $1,000,000 or over, which includes all metropolitan systems, the ratio has increased during this time from 54.8 to 58.4%. The wide range of values for this ratio in specific cases, shown by the accompanying table, warns against relying on one average. We have already noted specific rises to 1907 and the recovery—often to a new minimum. We have noted that economies may have been found

[6] See Eng. News, Jan. 26, 1911, p. 100.

[7] This figure is the average return from all fare and transfer passengers, indicating that there must be some passengers paying more than 3 cts.

FINANCIAL OPERATIONS OF 25 STREET-RAILWAY COMPANIES.

Property.	Stock.[1]	Bonds and notes.	Net earnings[2] in per cent. of stock.				Dividend rates.[3]					Total Reserves (1909) in per cent. of total stocks, bonds, etc.	Ratio operation expense to gross income.			
			1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.	1910.		1906.	1907.	1908.	1909.
Birmingham, Ala., Ry. Lt. & P. Co.	$3,500,000 P. 3,500,000 C.	$10,977,000	5.64	3.15	2.95	4.9	6% on Pref. 5	0	0[4]	0	2	....	57.4	68.6	66.1	61.5
Denver, Colorado, City Tramway Co.	5,000,000	7,187,000	....	13.0	13.9	14.0	6[5]	6	6	6	..	....	48.2	47.3	48.1	49.8
Connecticut Co., New New Haven	275,000	34,287,700	8.07[6]	11.4[6]	7.95[6]	8.3[6]	..	..	..	..	..	....	53.5	50.6	60.4	58.0
Washington, D. C., Ry. & El. Co.	8,500,000 P. 6,500,000 C.	13,093,518	3.49	3.81	4.82	5.0	5% on Pref. 0	0	0	1	..	6.00	51.5	51.7	49.9	51.7
Capitol Traction Co. Washington, D. C.	12,000,000	4,000,000	7.35	6.59	6.42	7.02	6	6	6	6[7]	..	8.64	....	....	43.1	45.1
Ga. Ry & El. Co., Atlanta	2,400,000 P. 8,514,600 C.	12,070,000	9.38	7.86	7.79	10.0	5% on Pref. 5[8]	39½[9]	6	6	..	7.6	....	....	....	....
Ill. Trac. Co., Champaign	4,552,600 P. 7,594,500 C.	24,956,813	6.92	6.51	5.30	6.20	6% on Pref. ..	6	6	..[10]	..	....	54.8	56.3	57.4	....
Indianapolis Trac. & Term. Co.	5,000,000	4,440,000	3.80	4.92	4.30	5.93	0	0	1	2	..	8.5[11]	....	....	....	....
Louisville, Ky., Ry. Co.	2,500,000 P. 5,456,500 C.	7,999,300	9.11	7.12	8.22	8.83	5% on Pref. 6[12]	6	4	4	..	3.44	....	....	....	....
New Orleans Ry. & Lt. Co.	10,000,000 P. 20,000,000 C.	32,811,900	....	2.49	1.90	2.39	On Pref. only. 5	4⅝	0	0	..	5.22	....	54.1	56.3	44.7
Portland, Me., R. R. Co.	1,999,538	2,447,500	4.70	4.63	4.77	4.68	3[13]	4	4	4	..	3.33	72.3	73.3	73.0	73.0
United Ry. & El. Co., Baltimore, Md.	54,000 P. 15,000,000 C.	55,306,000	6.47	6.89	5.86	7.18[14]	0	0	0	0	0	....	48.9	49.5	48.2	46.6
Springfield, Mass., St. Ry. Co.	2,258,000	1,275,000	6.47	7.66	8.26	8.44	8	7½	8	8	..	9.60	....	70.0	66.5	68.0
Detroit, Mich., United Rys.	12,500,000	24,903,000	7.28	6.71	5.6	6.95	6[15]	6	0	0	..	9.48	61.4	61.2	64.1	62.5
St. Louis, Mo., United Rys.	19,983,200 P. 24,913,800 C.	60,480,000	2.67	2.24	2.35	2.89	5% on Pref. ..	..	..	..	..	1.47	50.5	54.3	53.5	50.8
Omaha & Council Bluffs, St. Ry. Co.	4,000,000 P. 5,000,000 C.	9,433,000	4.42[16]	....	4.82	2.87	6% on Pref. 0	2	4	4	4	5.9[17]	41.2[18]	....	54.4	60.9
Public Service Ry., Newark, N. J.	37,487,300	41,131,500	....	5.48[19]	6.08[19]	7.12[19]	0	0	⅔	2	..	....	....	59.3	56.1	53.4
N. Y. State Rys., Rochester	8,362,500 P. 14,777,700 C.	5,918,000	2.38	2.48	1.72	5.13	5% on Pref. 0	0	0	0	1½	8.25	60.7	62.6	67.3	63.0
Cleveland, Ohio, Ry. Co.		14,675,600	9,251,000	....	....	6.66	12.18	5	3½	1½	0	1½	....	....	....	60.2	60.0
Phila. Rapid Transit Co.		30,000,000	14,400,000	1.0	−1.3[18]	−0.31[18]	−0.78[18]	..	..	..	..	..	2.41[18]	52.4	55.8	53.5	51.1
R. I. Co., Providence		8,510,400	414,000	6.40	1.83	2.29	5.52	0	0	0	5	..	4.98	53.8	88.6	61.0	55.0
Memphis, Tenn., St. Ry. Co.		2,500,000	8,300,000	4.96	3.85	3.43	4.1	5% on Pref. ..	..	..	..	..	3.88[20]	58.6	61.8	63.5	63.3
Va. Ry. & Pwr. Co., Richmond	4,700,000 P. 7,500,000 C.	9,778,000	2.18	2.73	2.38	3.04	..	..	..	..[21]	1½	5.80	70.9	67.0	72.0	65.6
Puget Sound El. Ry. Co., Tacoma	625,000 P. 3,500,000 C.	7,952,000	....	2.32	1.05	0.61	6% on Pref. ..	..	..	..	..	2.82	....	65.5	64.7	66.9
Milwaukee, Wis., El. Ry. & Lt. Co.	4,500,000 P. 9,000,000 C.	13,500,000	6.46	5.78	6.00	7.16	6	6	6	6	..[22]	2.44	47.2	50.3	49.8	48.1

[1] Common stock unless otherwise noted.
[2] Net earnings indicates surplus over operating expense and fixed charges, and depreciation, etc., where known.
[3] Includes figures on all stock.
[4] Panic and strike period; 3% in 1904 and 5% in 1905.
[5] 4% to 1902 and 6% since.
[6] Operating return from 32 properties (gross less op. exp), in per cent. total stocks, bonds, etc. Operating return paid to N. Y., N. H. & H. R. R.; 3% greater in 1909 than 1908.
[7] Paid 3%, 1899 to 1902; 4% to 1904; 5% in 1905.
[8] 2% in 1905.
[9] 6% regular plus 33⅓% stock dividend.
[10] 1909 div. not given; the surplus after paying 6% on pref. stock is 6.27% of common.
[11] Surplus for four years, 1906-09 only.
[12] Paid 2½% 1896-97; 1¼% 1898; none in 1899; 4% 1900-01; 4½% 1902; 5½% 1903-4; 6% to 1908.
[13] Paid 6% 1890 to 1899; 5% in 1900-1; 6% 1902; 3% to 1904; 1½% in 1905; 3% in 1906.
[14] Extraordinary expenses against this net income in 1906 amounted to 6.5% on the stock; in 1907 to 6.9%; in 1908 to 5.4%; in 1909 to 6.8%. These absorbed prospective dividends.
[15] First div. 1901, 4%; 4% to 1905; 6% 1905-1907; div. passed Nov., 1907, and since.
[16] For 1905.
[17] Operating return (gross earn. less op. exp.) in per cent. of total stocks, bonds, etc. Operating return paid to Public Service Corporation.
[18] Deficit, during panic and strike period, supplied from reserves.
[19] Total surplus for 1908.
[20] Four years' accumulation only.
[21] This company succeeded the Va. Passenger & Pwr. Co., which was foreclosed in 1909.
[22] Paid 4% in 1903; 5% in 1904-5, and 6% since.

to offset increased cost of materials and labor. One such economy which has been recently instituted, and which in many cases has increased the receipts, through the more careful collection of fares, is the introduction of prepayment cars and collecting boxes. Another economy is seen in the movement to check any ill-advised increase in weight of equipment,—a movement which is approved by many well-known street-railway engineers and car designers, looking to reduction of the dead weight of car per passenger, for economy in initial cost, depreciation, maintenance of rolling stock and roadbed.

The increase in the cost of some of the more important items comprising the equipment of a street railway are shown by Prof. Conway. The total average increase in the cost of rails, switches, frogs, ties, cars, coal, car-wheels and wages is 87%. In the aggregate this appears staggering, but if the figures are examined in detail, the blow is softened. In the much talked-of item of wages the increase is 5%. In switches, frogs and ties, it runs from 17 to 23%. The heavy items which bring up the average are 139% for heavier rails, 100% for heavier cars and 350% for the steel car-wheels. The paper neglects to show that this heavier equipment carries a greater burden of passengers and that the increase per unit of service must be very small or else the increase in the ratio of operating expense to operating earnings would have increased more than the claimed average of 3%. As already stated, the possibilities of profitably reducing some of these increased weights are also neglected.

This review of certain features of Prof. Conway's paper and the citation of the results of operations in several specific cases are not made for the sake of mere contention, however debatable his points may be. They are made, first, as another impersonal protest against the publication of sweeping conclusions and dark prophecies based alone on very general figures. They are made in the hope of showing again the need of pushing study to the limits of available data before such conclusions and predictions can be justified. Finally they are made as a protest against even indirectly lending the prestige of a people's university to a questionable discussion of a public-service question.

LETTERS TO THE EDITOR.

The Strength of Old Timbers.

Sir: In your issue of Sept. 15 last, I noticed a communication by Mr. G. B. Hazlehurst (p. 285) in reference to the assumed diminishing strength of old timber. I may say that this question was before me some years ago with reference to our bridge stringers, which are constructed of round or log timbers. It was found that after a period of 20 to 30 years there was no serious diminution in the cross-breaking strength. The timber dealt with was iron-bark, our best all-round Queensland hardwood. The average modulus of rupture for all experiments on aged timber was 12,000 lbs., after deducting 25% for the variation in scantling between the specimens (2 × 2-in.) and the actual girder. The working modulus we generally accept is 13,000 lbs., and this amounts to a reduction of only 7.7% on the old timber.

W. Pagan,
Chief Engineer, Queensland Railways.

Brisbane, Queensland, Australia, Feb. 2, 1911.

Police Administration in Havana.

Sir: I am very much impressed with the police system of this city. It seems that you cannot walk a single block without coming face to face with one of these officials. They are extremely polite, and, although they do not understand the English language, they do their utmost to assist you in finding any place that you happen to be looking for.

Upon arrival at the dock, a policeman hands you a card on which is printed in the English language: "Tourist's protection in care of National Police. In case of any accident apply to the Chief of Police, telephone A2158. Your coach is the No. 827, policeman No. 20." In handing you this card the policeman is particular to inform you that the price for the use of the vehicle from the dock to the hotel is 20 cts. Spanish silver. He tells you that if the driver finds any fault with the amount paid him, he is to be turned over to the nearest policeman—so different from our taxicab methods in the large cities of the United States. During the four days that I have been in this city, using these Victoria coaches a dozen times a day, I have had no trouble whatever with any of the drivers.

It might be a good scheme for the police of American cities, where drivers and chauffeurs charge whatever they choose, to study the Havana methods with regard to coach hire and adopt them.

A. E. K.

Havana, Cuba, March 3, 1911.

The Verb "To Tote" and Southern Colloquialisms.

Sir: In Engineering News, March 9, 1911, p. 297, you use, editorially, the past participle of the verb "to tote." The word is Southern, and probably of African origin, though its etymology is disputed. It may be of interest to some of your readers to learn that, in the South, its meaning is restricted to the performance of personal effort alone. A Southerner will never say he totes anything in a boat, wagon or car, but that he totes it on his back, in his hand or pocket, etc.

While on the subject of Southern colloquialisms, I wish to call the attention of your readers to the misuse of the expression "you all" by writers of fiction. They make the Southerner use the words in the singular number; whereas, as a matter of fact, the most ignorant and illiterate among us are never guilty of such a grammatical outrage. When a Southerner greets a friend or acquaintance with the words: "How are you all?" the person addressed, if he is a Southerner, knows that the greeting includes his family with himself.

D. M. Andrews.

Montgomery, Ala., March 15, 1911.

[Having in mind the same distinction made by our correspondent, we ourselves had some doubt about the use of the word "tote," to indicate anything but personal carriage, but finally decided to follow the example set by the author of the paper upon which we were commenting. As he is personally acquainted with the country where the "toting" took place, we presume that it must be a local use of the term.—Ed.]

Two Highway Bridge Designs for Comparison.

Sir: Apropos of the note in your Feb. 16 number on "A Bridge Collapse," it just happens that there is lying before me a strain-sheet for a 200-ft. span, 16-ft. roadway, which is practically identically the same loading as the span shown. This design is for a unit-stress of

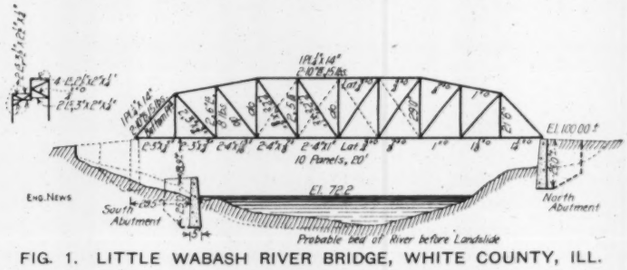


FIG. 1. LITTLE WABASH RIVER BRIDGE, WHITE COUNTY, ILL.

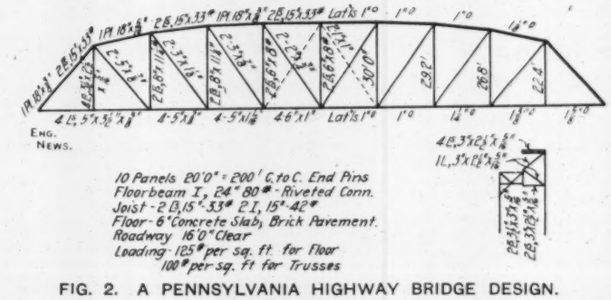

10 Panels 20'0" = 200' C. to C. End Pins
Floorbeam I, 24" 80# - Riveted Conn.
Joist - 2 B, 15" - 33# 2 I, 15" - 42#
Floor - 6" Concrete Slab, Brick Pavement.
Roadway 16'0" Clear
Loading - 125# per sq. ft. for Floor
100# per sq. ft for Trusses
ENG. NEWS.

FIG. 2. A PENNSYLVANIA HIGHWAY BRIDGE DESIGN.

17,000 in tension and the same properly reduced in compression. It is about a fair average for the grade of work called for by the better class of county officials in this section, and may make an interesting comparison with the strain sheet shown in the article referred to.

F. H. C.

Chambersburg, Pa., Feb. 22, 1911.

[For comparison we reproduce the Illinois bridge design from our issue of Feb. 16. It will be noted that the design shown by F. H. C. provides roughly double the sections of the other design.—Ed.]

The Swatara Bridge Again.

Sir: In your issue of March 16, 1911, p. 3[illegible] appeared two letters under the following [illegible] A Criticism of the Swatara Creek Bridge, Humm[illegible]wn Pa." While the idea of Mr. French of designin[illegible]che to eliminate optical illusion strikes me as u[illegible]e, it seems to me that his contention against "departu[illegible] from usual practice of such bridges" is not well founde[illegible] when one notices the number of bridges with saggin[illegible] panels and settling foundations on the ordinary high[illegible]. It would seem that almost any departure in favor[illegible] Some permanent structures was desirable. Perso[illegible]. It would seem to me that if added weight were [illegible]ed to would be an advantage to put it into the piers [illegible]arch ring of the bridge proper rather than in the f[illegible] be tween spandrel walls. If for no other reason, [illegible]er, than that of an educational one the added cost [illegible]ing for a bridge would be worthy of consideration, a [illegible]small piece of good road might induce the community [illegible]make some much needed general improvements.

It seems regrettable that the present system, o[illegible]ther lack of system, of keeping records of highway re[illegible]s and renewals does not give us sufficient data from [illegible]which capitalized value of these items could be ascerta[illegible]ined and the justifiable expense for new structures calcula[illegible]ted. At present about all that seems to be known, in thi[illegible]s on of the country at least, is that the cost of maint[illegible]enance is too high, and while one may differ with Mr. Pratt as to matters of detail, his idea of making a brid[illegible]ge that will "stay put" is along the right line.

J. N. Brid[illegible]

University of Nebraska, Lincoln, Neb., March 20, 1911.

Agricultural Engineering.

Sir: An editorial in the "Experiment Station Record for February, 1911, upon the question of the training of men for work in Agricultural Engineering is of unusual interest. The "Record" is a monthly periodical published by the Department of Agriculture in Washington, in which are reviewed and abstracted all articles or books upon agricultural subjects or along lines of interest to agricultural investigators.

The editor of that publication is a man of long experience and ripe judgment and is therefore entitled to speak as an authority on such matters. He calls attention to the fact that in 1909 there were 31,748 engineering students in the universities, colleges and technical schools of the United States, and that of this number 17,862 or 56% were in the land-grant colleges—those schools which receive aid from the Federal treasury. In all the 67 land-grant institutions only one, the Iowa State College, is a course in Agricultural Engineering offered. Several institutions have Departments of Agricultural Engineering, and nearly all give some course which should form a part of a practicing agricultural engineer's training yet none seem to offer a thorough course on broad lines.

Agriculture is rapidly becoming a business, and though greatly varied in its branches, there are certain well-defined underlying facts which need trained men for their application. There is as much need for engineering skill in the development and management of a large ranch property as in the investigation and working of a mine, and often with much larger returns.

In America the profession of agricultural engineering has too long been neglected, and many have been the errors which have resulted from our neglect. Too often the term agricultural engineer has been thought to refer only to men trained in the building of farm machinery. The profession should be broader. It should include within its scope all those branches of knowledge which have to do with agricultural development. It should include besides agricultural machinery, farm buildings and development, irrigation, drainage, and roads. A man who specializes in agricultural engineering will find his business as broad as that of the man who calls himself a mining engineer.

No one nowadays can expect to excel in all phases of any business and so there is a call for specialists in some of the branches of the profession, such as irrigation engineering, road engineering and drainage engineering. It is too often true that men trained in these lines are not trained in the fundamentals of agricultural engineering.

It is difficult to see how a man with no knowledge of agriculture can design and construct an irrigation sys-

tem, an engineering work which has solely to do with the raising of agricultural products. It would be just as reasonable to expect a man who knew nothing of ships to build a system of docks. Many of the failures in irrigation systems in recent years are due to this lack of knowledge of the requirements of plants and the failure to secure reliable advice about the soils, the amounts of water required, the desirability of drainage, and a hundred other questions, all of which any properly prepared agricultural engineer would have inquired into.

Had the development of the irrigation districts of the West been in the hands of irrigation engineers, whose foundational training had been in matters agricultural, it is likely that irrigation securities would be a much more desirable commodity in the money market to-day.

One of the reasons why this branch of engineering is so little developed in America as compared with conditions in Europe is that until very recently there was little tendency for capital to go into agricultural investments. The man with a few acres found little need for technical help. A very important change has come over the industry in the last few years, a change brought about by the success of trained men. Agriculture is fast becoming a business in which highly trained men are the most successful and in which the untrained man is rapidly losing out.

This knowledge of the value of special training and technical experience has caused a demand for agricultural engineers. There are to-day a number of men in active practice and there is need of many more.

Agricultural engineering courses are needed in more of our colleges and universities, but in establishing such courses let us not forget that the foundation must be a knowledge of agriculture itself, and furthermore, it should be understood that the drainage and irrigation engineers springing up cannot do the work there is ahead of them unless they possess a practical knowledge of the agricultural principles and practices which must be brought into play before the works which they construct are to be made profitable and successful.

Thos. H. Means,

57 Post St., San Francisco, Cal.

A Heavy Water-Flow Encountered in Driving the Strawberry Tunnel.

Sir: Accompanying copies of photograph and sketch show some details in connection with the heavy flow of water encountered in the Strawberry Irrigation Tunnel, during the latter part of December, 1910.

FIG. 1. WATER FLOW AT STA. 105 + 36, STRAWBERRY IRRIGATION TUNNEL, U. S. RECLAMATION SERVICE.

The photograph was taken a few days after the flow was encountered at Station 105 + 36. When the water was first encountered in quantity, the discharge from the face hole, shown on the photograph, was between 4 and 5 sec.-ft.

During January the tunnel was driven ahead 150 ft. The several crevices that were cut have all added considerably to the amount of water coming in. On February 1, 1911, the total flow from the heading was between 7 and 8 sec.-ft.

The material in the tunnel where the water is being encountered is a combination of hard, blue limestone and sandstone that stands pretty well for a time, when the exposure to air and moisture cause considerable disintegration.

The Strawberry Tunnel is one of the main features of the Strawberry Valley Irrigation Project, being constructed by the Reclamation Service in Utah. It is 19,200 ft. long and to date 10,686 ft. have been driven.

J. L. Lytel, Project Engineer.

Provo, Utah, Feb. 24, 1911.

A Method of Giving Centers on Old Curves Without Field Computation.

Sir: I recently had to give centers on quite a number of curves and have used a method that does not require any field computation and saves considerable time. It is a convenient method of giving centers of curves on old track where the points of curvature are not marked and the intersection points are inaccessible.

On most of the old constructed roads nearly all the curves are in even degrees, and most of the railroads have on record in their offices the degrees of all their curves. However, if the degree is not given any one familiar with such work can determine the degree of curvature in a few minutes.

Knowing the degree, set two stakes A and B'' on the tangent, B'' being set where the curve seems to begin. Instead of using stakes when hunting for the P. C., wire nails can be used to better advantage. These should be left standing up high enough to be readily found. Set these points every 100 ft. from the point B'' on a curve of the same degree as the one to be relined.

If after 400 or 500 ft. have been run the stakes go some distance from the present center of the track as at F, in the accompanying sketch, set another point on the tangent AB'' at B', which will be nearer the true point. This can usually be guessed at within a few feet.

If after running a few hundred feet this is found to be considerably off center move the point B' nearer the true point. Run the curve $B'H'I'$ around to C'', which is not quite the end of the curve, taking turning points at H' and I', and at other points if necessary. To make mistakes less likely take turning points the same distance apart each time.

Set two stakes on the line of the other tangent ED. The point E is set at right angles to C''. Measure distance EC''. Set instrument at C'' and take a backsight on the last turning point I' and a foresight on D'', which is set at the distance EC'' from D.

Having turned off the deflection angles consecutively with the lower motion clamped, the angle reading on the instrument will be angle $\triangle$ or the intersection angle of the tangents. By knowing the degree of curvature and angle $\triangle$, the length of curve is readily obtained. Then continue the curve the proper distance to C' The curve $B'H'I'C'$ will be the same length as the curve $BHIC$. Set the instrument at C' and set off angle $\triangle$ from tangent $C'D'$, setting the point C where the line CC' crosses the tangent ED. This is the true P. T. Measure $B'B$ equal to distance CC'. The point B is the correct P. C.

If necessary any intermediate point, H or I, may be set by measuring HH' or II' parallel and equal to CC'.

I have found that this method is just as accurate as measuring the intersection angle and saves considerable time. It does not involve any field computation and the points on the curve $B'H'I'C'$ should always be the same distance, CC', from the points on the curve $BHIC$. This gives a check on the work at any point, and if a mistake is made not many permanent stakes will be set before it is discovered. I have used this method very extensively and find that it requires from one-third to one-fourth less time to give centers than that by finding the intersection angle.

J. R. Baylis,

Assistant Engineer, International & Gt. Northern R. R. Palestine, Tex., Feb. 11, 1911.

[Substantially the same method as that given above was printed in Engineering News for April 10, 1902, in a letter of Mr. R. W. Willis, now District Engineer of the Chicago, Burlington & Quincy R. R.

Mr. Willis here stated, that after running off the embankment on the first trial,

he then measured the distance to the center of track and divided it by twice the sine of the deflected angle, and moved his P. C. back or ahead, according to whether his curve ran off outside or inside of the track. From this second P. C. he usually got around without difficulty. At each turning point he set a tack ahead or back of the turning point and on a line parallel to the original tangent, so that by stretching a string between the turning point and the tack, the final points could be measured back without setting up the instrument again. When he reached the end of the curve and turned off a tangent parallel to the track tangent, he figured the amount of "pull" ahead or back to come into the tangent and by moving his turning point along the line parallel to his original tangent the same distance he moved his P. C., he had the whole curve established.

It will be seen that the method given by Mr. Baylis is a kind of graphical solution of the

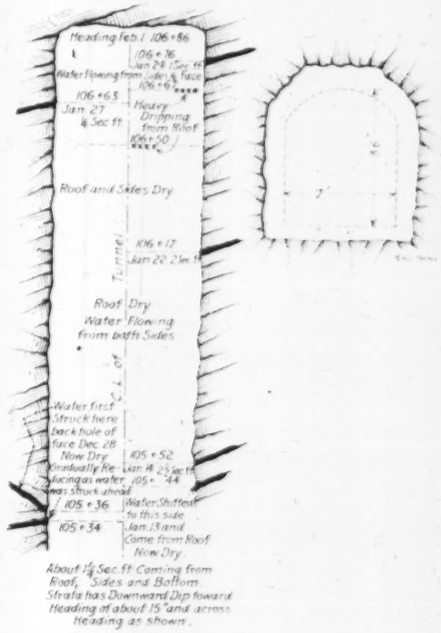
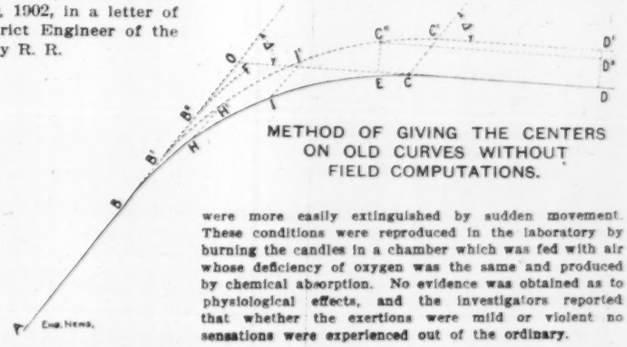

Heading Feb 1 106+86
106+76
Jan 24 1Sec ft
Water Flowing from face & face
106+63
Jan 27
4 Sec ft
Heavy Dripping from Roof
106+50
Roof and Sides Dry
106+17
Jan 22 2Sec ft
Roof Dry
Water Flowing from both Sides
Water first Struck here back hole of face Dec 28
Now Dry
105+52
Gradually Increasing water was Struck ahead
Jan 14 25 Sec ft
105+44
105+36
Water Shut off to this side Jan 13 and Came from Roof Now Dry
105+34
About 1/4 Sec ft Coming from Roof, Sides and Bottom
Strata has Downward Dip toward Heading of about 15° and across Heading as shown

Fig. 2. Ground Plan Sketch of Water Zone, Strawberry Tunnel, Dec., 1911, and Jan., 1911.

(From drawing made Feb. 4, 1911.)

other, worked out on the ground to full scale. It therefore has the advantage noted, that no computation other than a little mental arithmetic is required.

A very complete treatment of the problems and methods of relining old railway track will be found in Engineering News of Sept. 17, 1908, in an article by W. H. Wilms.—Ed.]



METHOD OF GIVING THE CENTERS ON OLD CURVES WITHOUT FIELD COMPUTATIONS.

ROBBING AIR OF OXYGEN has been investigated by Messrs. F. W. McNair and G. A. Koenig at the Victoria Mine, Ontonagon Co., Mich., and reported in the "Compressed Air Magazine" for March, 1911. In this mine, trouble was experienced with the candle flames and investigations were undertaken to find if the air supply, which was hydraulically compressed, was not deficient in oxygen. Determinations with a Hempel pipette showed an oxygen content of 17.7 volumes in 100 volumes of compressed air, whereas a normal air contains about 21 volumes of oxygen in 100. It was at first doubted that this shortage of 3.3 volumes of oxygen could cause the reported trouble with the lights or lead to the question of deleterious effect on the workmen. The shortage of oxygen, of course, results from the greater solution of the oxygen of air than of the nitrogen by water during the time of compression. Unquestionable evidence was secured that, in the hydraulically-compressed air supply, the candles had a shorter and blunter flame and were more easily extinguished by sudden movement. These conditions were reproduced in the laboratory by burning the candles in a chamber which was fed with air whose deficiency of oxygen was the same and produced by chemical absorption. No evidence was obtained as to physiological effects, and the investigators reported that whether the exertions were mild or violent no sensations were experienced out of the ordinary.

Reinforced-Concrete Viaduct Between Dallas and Oak Cliff, Texas.

One of the longest reinforced-concrete arch viaducts ever built is now under construction across a shallow valley between Dallas, Tex., and a suburb known as Oak Cliff. We have received from Mr. V. H. Cochrane, M. Am. Soc. C. E., a member of the firm of Hedrick & Cochrane, Kansas City, Mo., which is in charge of the construction of the bridge, an extensive account of the work. From this account we have prepared the following article.

General Description.

The Trinity River, ordinarily a small stream not more than 200 ft. wide, runs in a shallow valley between the city of Dallas and its suburb of Oak Cliff. At flood stages, however, the river rises sometimes as much as 50 ft. and spreads across the whole width of its mile and a half valley, completely shutting off the suburb from the main city. Some time ago it was decided that to avoid such interruptions in traffic it would be necessary to build a bridge or viaduct across the river and its valley, and accordingly the County of Dallas about two years ago voted a bond issue of $600,000 with which to build the structure. These bonds were sold and, after a sufficient amount was reserved to cover the cost of the right-of-way and the Oak Cliff approach, a fund of $563,000 remained available for the construction of the bridge. The county is undertaking the work alone without the aid of either the city of Dallas or the city of Oak Cliff. Although at one time the railroads whose tracks were being crossed were expected to contribute something towards the cost of construction, up to this time no such contributions have been received.

In November, 1909, the County Engineer, Mr. J. F. Witt, advertised for competitive plans to be submitted on or before Jan. 1, 1910. This advertisement contained the following chief requirements:

(1) The structure must be of reinforced concrete, of either arch or trestle construction, and must provide a roadway for vehicular traffic, and two sidewalks. Provision must be made for a double track electric railway to be added at some future time.

(2) The clear width between hand rails must be not less than 50 ft., and should be more if a wider structure can be built at a cost not to exceed the amount available.

(3) Conduit spaces easy of access must be provided, having a cross-sectional area of not less than 20 sq. ft.

(4) The live loads to be provided for are as follows:

On each electric railway track, two 100,000-lb. cars.

On the roadway, 100 lbs. per sq. ft., or a 15-ton road roller having a maximum axle concentration of 10 tons.

On the sidewalks, 80 lbs. per sq. ft.

(5) The design should be more than a mere picture or side elevation; sufficient details should be given to enable the relative merits of the design to be determined. Each designer shall furnish a complete analysis of the principal span or spans, and a complete list of working stresses; also sample specifications, an itemized estimate of cost, and a summary of his professional experience.

The County Court appointed an Advisory Board, consisting of Prof. T. U. Taylor, M. Am. Soc. C. E., Professor of Civil Engineering, University of Texas; Mr. Otto H. Lang, M. Am. Soc. C. E., and Mr. N. Werenskiold, to examine the various designs submitted and to report upon them to the court. Out of the 15 designs submitted, the Board recommended the adoption of the arch design submitted by Mr. Ira G. Hedrick, M. Am. Soc. C. E., Kansas City, Mo., with Mr. M. R. Ash, M. Am. Soc. C. E., as associate engineer. With two exceptions Mr. Hedrick's preliminary design was substantially the same as that adopted for construction. These exceptions were the final adoption of piled [illegible] instead of spread reinforced-concrete foot[illegible] the widening of the roadway of the bridge [illegible] ft., with two 5-ft. sidewalks, to 44 ft., with [illegible] ft. sidewalks. The first of these changes [illegible] quired by the order of the Advisory Board [illegible] was not sufficiently satisfied with the [illegible] jointed clay soil which was discovered [illegible] ings to guarantee the 2-ton per sq. ft. re[illegible] concrete footings originally designed. The change was made because it was found [illegible] contract price was enough less than [illegible] mated cost to enable the widening.

Fig. 1 is an elevation of the structure [illegible] ning at the Dallas end, it comprises [illegible] reinforced-concrete trestle construction;

FIG. 1. GENERAL ELEVATION AND PART PLAN OF [illegible]

forced-concrete arches, each 71-ft. 6-in. [illegible] 98-ft. concrete covered steel plate gi[illegible] over the river (with 90 ft. clear opening); [illegible] reinforced-concrete arches of 71-ft. 6-in. [illegible] and 181 ft. of reinforced-concrete trestle; total length of 5,106 ft. At each end there is a decided angle in the line of the roadway in the trestle approach portion. It will be noticed that at ordinary river height all but the middle span will be over dry land. At high water, however, the water level will reach to the trestles. The large girder in the middle was required because the U. S. War Department demanded a 300-ft. horizontal clearance and a 60-ft. vertical clearance throughout the entire width of 90 ft. at the river. In order to keep the grade of the viaduct as low as possible, it was therefore necessary to have a girder, and the engineers thought it better that this girder be of steel encased in concrete than of the heavier reinforced-concrete type.

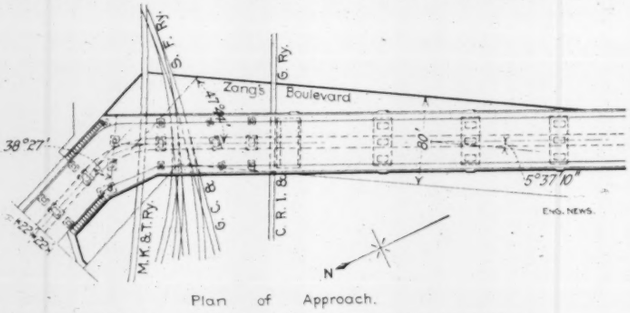


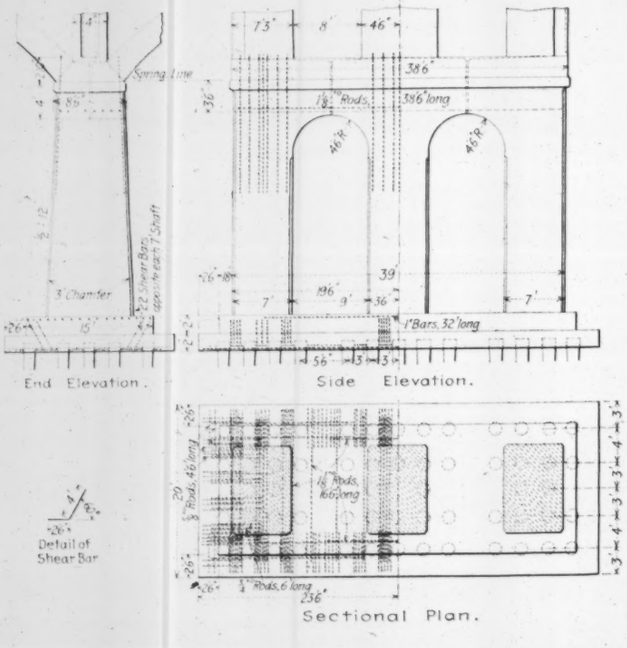
FIG. 2. PLAN OF DALLAS END OF VIADUCT.

Foundation.

The specifications and drawings call for concrete piles for all piers except the two river piers, where long timber piles are used. For the concrete piles the following tests were prescribed:

The safe load assumed for each concrete pile is 30 tons and the contractor will be required to test four piles. Each of the test piles shall first be loaded with 30 tons for 48 hours and must show no settlement. Each pile shall then be loaded with 60 tons and shall show not more than ¼-in. settlement after the load has been applied for 48 hours. Should the test piles fail to sustain the load specified, the contractor must increase the size and length of piling or increase their number, without extra charge, so that in the opinion of the engineer the piling used will carry safely a load equivalent to 30 tons for each pile shown on the plans.

It was soon found that this provision was beyond the possibility of the piles, so it was decided the working load on the piles be reduced from 30 tons to 20 tons each and that the bases of the piers be increased in size. The contractor agreed to stand the extra expense involved, and accordingly the piers were redesigned for the following working loads:



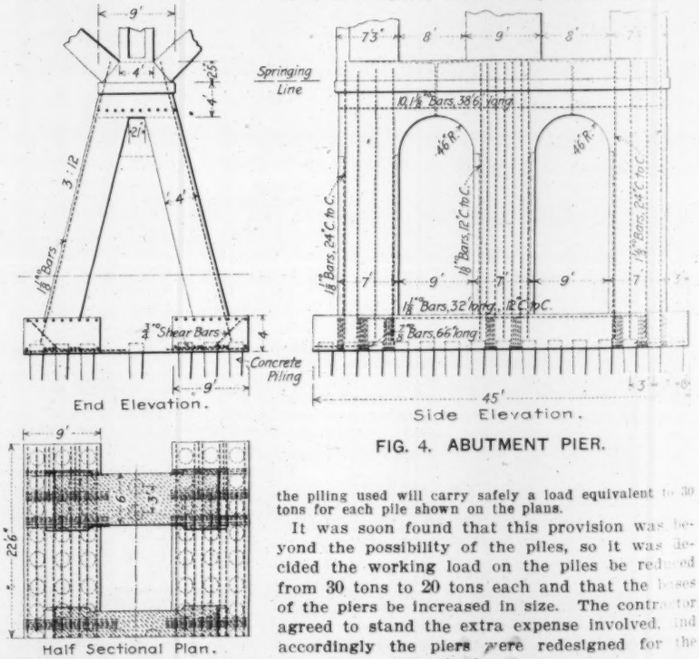


FIG. 3. TYPICAL ARCH PIER ON DALLAS-OAK CLIFF VIADUCT.

FIG. 4. ABUTMENT PIER.

	Unbalanced live load condition.
Extreme load per pile, tons	20
Extreme soil pressure, tons, per sq. ft.	1.6

Several tests of the soil were made and fairly uniform results were arrived at. This soil is a hard, compact black or yellow clay underlaid by sand or sand and gravel in places. As the clay is very dry, owing to the long drought which has prevailed at Dallas, the bearing capacity of the soil was tested by pouring water into the pits and allowing it to stand. According to most of the tests, it appeared that under a constant load, settlement continues for a few hours and then practically ceases. When the load was increased to ten tons about, water was added to the pit and was kept standing 3 ft. deep. On the whole, the settlement was proportional to the load, varying in one typical case from 1/16-in. under six tons to ¼-in. under 10 tons per sq. ft. A maximum load of 20 tons produced a permanent settlement of about ⅜-in. This test was made with a 3½ × 3½-in. timber bearing on the soil, but the same results practically were given with a 12 × 12-in. timber.

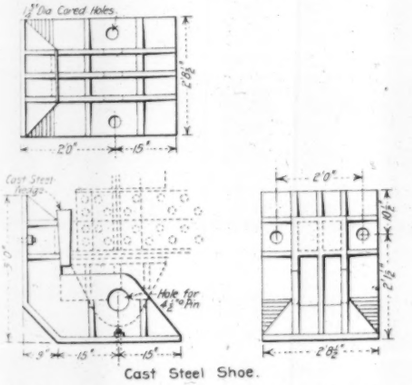
THE DALLAS-OAK CLIFF CONCRETE VIADUCT.

The concrete piles were made in place by pouring a 1:2:4 concrete into holes prepared by driving a core into the ground and then withdrawing it. The average penetration was about 14 ft. The following table gives the results of two groups of typical tests on concrete piles in place. One is a hammer test and the other a load test.

Pile No.	Penetration, ft.	Blows per inch, last 6 ins.	Settlement in inches under a load of 10 tons.	20 tons.	22½ tons.	25 tons.	30 tons.
32	13	40	0	0	....	....	0
35	11.5	54	0	0	....	....	3/8
82	13.5	40	0	0	....	....	3/8
85	14	28	0	0	....	....	0
39	14.8	42	0	1/16	1 1/16	1 7/16	1 3/4
42	14	48	0	1/16	1 1/16	1 1/2	1 11/16
60	14	60	0	3/8	5/8	5/8	1 7/16

Weight of hammer, 7,000 lbs.; stroke, 36 ins.
Weight of ram, 3,000 lbs.
Weight of former, 4,700 lbs.; Diam. at top, 14 ins. at bottom, 10 ins.

Some of these piles were exposed after being tested, and it was found that several were cracked in one or more places. It appeared that these cracks were caused by the vibration of the ground while the adjacent piles were being driven, and were made while the concrete was green. In a few cases the cracks had opened ½-in. showing that the soil had risen and had lifted the upper portion of the pile. In some cases the cross-sectional area of the pile had been reduced owing to the pressure of the surrounding soil caused by driving adjacent piles. It was found to be impossible to tamp the concrete into the soil so as to increase the diameter of the piles. The subcontractor who was driving the piles was not willing to undertake to remedy these defects by changing the methods of driving and forming the piles. It was decided that it would be safe to assume that the piles would carry an average load of 20 tons each so the subcontractor agreed to increase the size of the bases of the piers at his own expense so as to make good the deficiency in the carrying capacity.



Cast Steel Shoe.

FIG. 5. DETAILS OF PIER FOR SUPPORT OF MIDDLE GIRDER SPAN, DALLAS-OAK CLIFF VIADUCT.

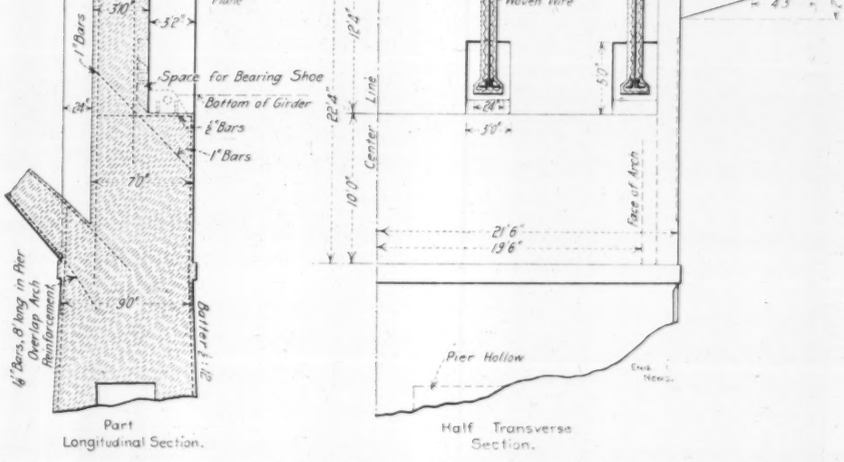
Piers.

There are several types of piers in the bridge. The standard arch pier is shown in Fig. 3. Every fifth pier in the arch span (Fig. 4) is made sufficiently large to resist the deadload thrust of one adjacent span in case the arch on the other side of the pier should fail. The two piers on either side of the river span are of special design to carry the horizontal thrust of the arch spans in bending (Fig. 5). The tension side of each pier is reinforced with corrugated bars. These piers will be founded on 168 timber piles. The abutment pier at the Dallas end of the arch span was carried down to bed rock. The other abutment pier was founded on piles, one-half of which are driven on a slope of 4½ ins. to 1 ft. to care for the horizontal thrust.

Both the ordinary piers and the so-called abutment piers are pierced longitudinally by two openings 9 ft. wide spanned at the top by arches. The distance from the springing line to the top of these openings is 4 ft.; the reinforcing bars are placed just above them.

Trestle.

The trestle is a reinforced-concrete slab resting on longitudinal girders, which in turn rest on cross walls supported by three columns. The details are shown in Fig. 7. The only extraordinary feature of this design is the rocker bearing provided for the girders shown in Fig. 7. On one side of the cross girder the longitudinal girders are rigidly connected to it by means of a reinforced-concrete bracket. On the other side each longitudinal girder rests on a socket formed by two bent copper plates extending the full width of the girder, the lower plate resting on the cross girder and the upper being fastened to the longitudinal girder. The longitudinal girders on either side are connected by means of reinforcing bars just above the socket, but a cleavage plane is left between them extending through the floor slab so that the girder which rests in the socket is more or less free to rotate. The girders are thus discontinuous and are designed as simple beams. At suitable intervals expansion joints are introduced. At these joints the lower copper plate is replaced by two cast-iron plates, the lower being imbedded in the cross girder and the upper sliding on it, as also shown in Fig. 7.



Arches.

Each arch is 71 ft. 6 ins. clear span and 79 ft. 6 ins. c. to c. of piers with a rise of 17 ft. It consists of a solid arch span, reinforced, as shown in Fig. 6, in upper and lower planes and carrying a flat slab floor by means of vertical cross walls pierced by openings so as to make really three columns carrying the transverse girder. The roadway is so arranged as to allow for a future railroad track, but at present only a macadam roadway has been placed. Expansion joints are provided in the floor slab over the second column from each pier, and the sections are separated from each other by a strip of asbestos board. It will be noted that the roadway slab, the curb and the sidewalk slabs are in one integral piece, but that the sidewalks are supported from a cantilevered bracket.

Concrete-Encased Girder.

The span over the river consists of four steel girders 98 ft. between supports, connected by steel cross girders, the whole to be encased, as shown in Fig. 8, in concrete. The steel girders carry in direct compression the horizontal thrust of the adjacent arch spans. This thrust is carried into the bottom flanges of the girders by means of the special cast-iron shoe shown in Fig. 8. The upright portion of the shoe bears against the concrete of the pile on one side and against the cast-steel wedge on the other, the wedge being driven between the cast-steel shoe and the end of the bottom flange angles. In all other details the girders are of the usual type of construction.

Material.

After a number of tests by Prof. T. U. Taylor as to the relative strength of concrete made with Dallas gravel and Jacksboro stone, the only crushed stone available in the vicinity, it was decided that the gravel concrete was quite as strong as broken-stone concrete for 1:2:4 mixtures, though for leaner mixtures the broken stone showed up better. Consequently, a sand and gravel concrete of 1:2:4 mixture was prescribed, with the proportions to be modified if the engineer so decided. The specifications for the grades of concrete are as follows:

For the arch rings, girders, cantilevers and spandrel walls (above a plane through bottom of cantilevers), and for girders, bents, floor slabs and arch piers (above a plane 3 ft. 6 ins. below the springing line of arches), and

for encasing the metal work for the steel span over the Trinity River, the concrete shall be composed of one part Portland cement, two parts sand, and four parts stone or gravel to pass in any direction through a 1½-in. ring.

Concrete in all cross spandrel walls (below the plane of bottom of cantilevers), in the arch piers (below a plane 3 ft. 6 ins. below springing line of arches), and in the two end abutments and retaining walls shall be composed of one part Portland cement, three parts sand, and five parts stone or gravel to pass in any direction through a 1½-in. ring.

Concrete for curbs, wheel guards, sidewalks and parapets or copings shall be composed of one part Portland cement to three parts of a mixture of clean sand and gravel to pass a ½-in. screen.

The bases of all piers, columns and abutments shall be composed of concrete mixed in the proportions of one part Portland cement, three parts sand and five parts gravel to pass in any direction through a 2½-in. ring, or if broken stone be used the proportions shall be one part Portland cement, three parts sand and six parts of broken stone to pass a 2½-in. ring.

The reinforcing bars are of round corrugated shape and of medium open-hearth steel, having an ultimate strength of 60,000 to 68,000 lbs. per sq. in.; elastic limit not less than the ultimate strength; elongation of 22%; and the capacity to bend cold 180° to a diameter equal to the piece tested without fracture on the outside of the bend.

Loads and Stresses.

The live loads for the final design were the same as required in the case of the competitive plans. The electric railway loads were increased to allow for impact, 50% for floor slabs and about 13% for arch ribs. No impact allowance was made for the road roller concentrations or the uniformly distributed loads on roadways and sidewalks. The piers were designed for two conditions of loading; first, four 100,000-lb. cars, 80 lbs. per sq. ft. on a width of 22 ft. of roadway outside of the car tracks, and 60 lbs. per sq. ft. on sidewalks, all symmetrically disposed on the two adjacent spans so as to produce balanced horizontal thrusts; second, four 100,000-lb. cars, 40 lbs. per sq. ft. on a width of 22 ft. of roadway, and 30 lbs. per sq. ft. on sidewalks, all on one of the two adjacent spans and producing an unbalanced horizontal thrust of 7,000 lbs. per lin. ft. of width of arch ring. For the latter condition, which is considered quite unlikely to occur, it was computed that 2,000 lbs. could, if necessary, be carried through the adjacent arch rib to the next pier, thus leaving an unbalanced live load thrust of 5,000 lbs. per lin. ft. of width of arch rib to be taken care of by the pier, or 195,000 lbs. altogether.

WORKING STRESSES.

Maximum compression on concrete in arches, excluding temperature stresses	500 lbs. per sq. in.
Maximum compression concrete in girders	600 " " " "
Maximum compression on concrete, including stresses due to 80° F. variation in temperature	750 " " " "
Maximum shear on concrete, plain	30 " " " "
Maximum shear on concrete, reinforced for shear	100 " " " "
No tension in concrete will be allowed.	

When temperature stresses are included, the steel reinforcement takes the entire bending moment without being stressed in tension above its elastic limit.

The total cost of the structure, including engineering and all incidentals, will be about $570,000, or about $2.10 per sq. ft. of floor. The contract is held by Corrigan, Lee & Halpin, Kansas City, Mo., who are doing the work, and the concrete piles are being put in place by the Gulf Concrete Construction Co., Houston, Tex. Field work is being carried out under the supervision of Hedrick & Cochrane, Consulting Engineers, Kansas City, Mo., and J. F. Witt, County Engineer. E. N. Noyes is Resident Engineer, representing the Consulting Engineers. Work was begun October, 1910, and should be completed by Dec. 1, 1911.

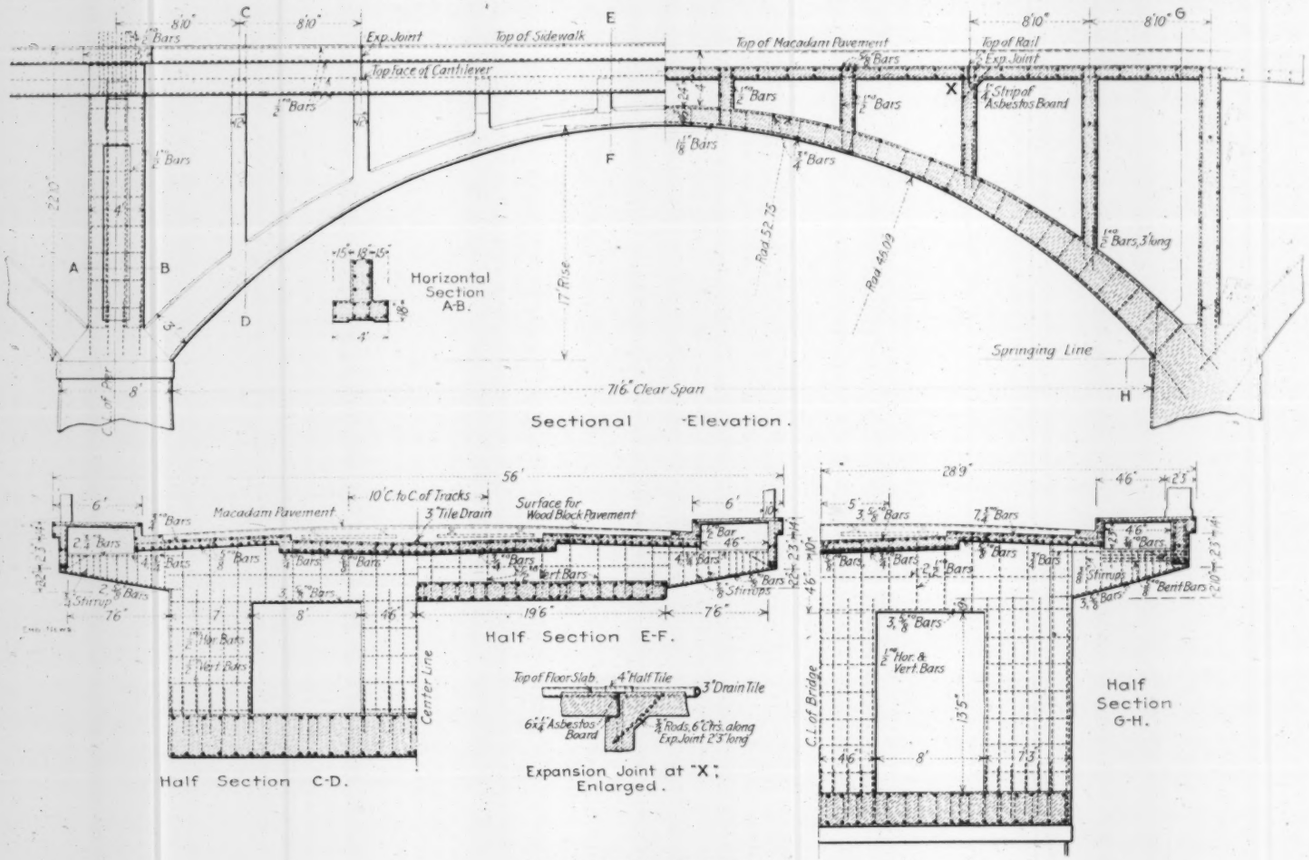


FIG. 6. DETAILS OF ARCH SPAN.

THE LARGEST CANTILEVER CRANE in the world, according to London "Engineering," was recently installed in the Imperial Japanese Navy Dockyard, Yokosuka, by Messrs. Cowans, Sheldon & Co., Ltd., Carlisle, Eng. It is designed for a working load of 200 tons, carried at the end of a 95-ft. radius, and has been tested with 250 tons at that radius. The same firm has under construction for the Japanese navy yard at Kure, a similar crane, designed for a safe load of 200 tons at 105-ft. radius. The capacities of some large cantilever cranes now in existence are as follows: Kure, 26,250 ft. tons; Yokosuka, 23,750 ft. tons; Devonport, Eng., 22,800 ft. tons; Clyde, Eng., 18,750 ft. tons.

Lighting The Double-Hump Yard of the Missouri Pacific Ry. at Dupo, Ill.*

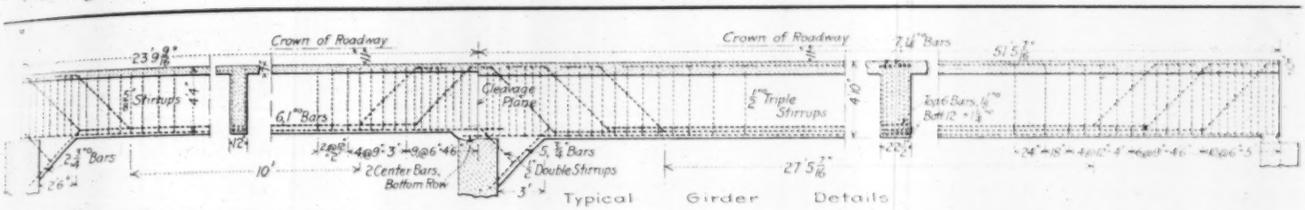
At Dupo, Ill., about 13 miles southe[ast] of St. Louis Union Station on the St. Louis, Iron Mountain & Southern R. R. of the Missouri Pacific Ry. system, is located one of the largest double-hump freight yards in the West, designed to handle both north and south-bound traffic, each hump having a capacity of 120 cars per hour. The yard is about three miles long and about 800 ft. wide at the classifying yards, with connections to the railroad company's Illinois division, East St. Louis, Ivory Ferry, the terminal Railroad Association, and other systems. The yard is divided into receiving, classification, forwarding, storage, caboose and repair yards. The two humps, the roundhouse, repair yards, coal and water stations, and the power house, together with a hotel and other facilities are lo-

cated at practically the longitudinal center of the yard, making it very nearly symmetrical.

Under the direction of the Construction Department of the Missouri Pacific Railway Co., Westinghouse, Church, Kerr & Co. in 1906, acting as Engineers and Constructors for the Railway Co., designed, constructed and equipped their Dupo power house. The following year the Engineers were instructed to investigate and recommend a system of artificial illumination for the yard. All of the commercial systems of out-door arc lighting were investigated, but as the power house contained alternating-current equipment, the direct-current systems could not be given serious consideration. Owing to business conditions, all work in the yard was suspended from 1907 to 1909, in the Fall of which year the subject was again taken up, and as many improvements had been made in the different lighting systems, another investigation and report was made which included flaming arcs in addition to the systems previously considered.

Several installations of flaming arcs were visit-

*Description prepared by Mr. W. S. Austin, for Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City.



…n and around New York, including those …the Bush Terminal yards, the New York …ral yards, and a foundry installation. In a …ion of the foundry, the carbon arcs, which …flaming arcs had superseded, had not been …ved, making it possible to study the effect, …sity and quality of light produced by both …ems by using first one system and then the …ther.

…ests made show that in direct sunlight an …in. high, white-chalk figure made on a brown …kground with a ½-in. diameter crayon, could …d up to 275 ft., and that on a dark night …the flaming arc the same figure could be …at a distance of from 100 to 150 ft., depend…ing upon the position of the board with relation …the lamp, and that under the same conditions …with carbon and other white-light arcs, the fig…ures could not be read more than one-half the distance possible with the flaming arc. This had an important bearing on the selection of lamp, as in operating the humps it is necessary that the men in the switch towers at the entrances to the classification yard be able to read the car numbers at a distance of from 100 to 175 ft. in order to throw the proper switch in front of the approaching car.

A detailed investigation and study showed the candle-power of the flaming arc was greater than that of any other type, that the quality of light generated by it was better suited for this installation than that produced by any of the other lamps, as the penetration in clear weather, as well as in smoke and fog, was greater than with any of the other types, and it had the further advantage that the unshaded lamps would not blind or dazzle the eyes of the switching crews while working around the yard, even though they looked directly at the lamp or beyond it, thus making it unnecessary to provide expensive and complicated reflectors and shades.

A comparative study of the different kinds of flaming arcs was made to determine reliability, freedom from interruption, length of burning between trims, cost of operation, repairs, maintenance, etc., with the result that the regenerative flaming arc, manufactured by the Adams-Bagnall Electric Co., was recommended for this installation.

The lamps are spaced closest around the humps, the distance between the lamps increasing through the classification yard and out into the forwarding and receiving yards, where some of the lamps are spaced 600 ft. A spacing of 400 ft. was found to give a very satisfactory illumination for general work with the lamps located 40 ft. above the rails, making it possible for men standing on the cars to see underneath the lamps.

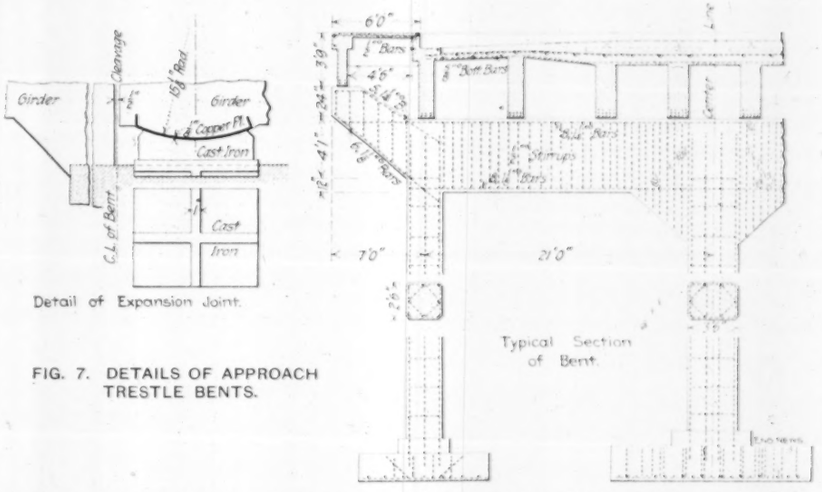


FIG. 7. DETAILS OF APPROACH TRESTLE BENTS.

The problem of locating the different lamps was worked out in conference with the railway engineers, and when the system was put in service it was found necessary to move but one of the lamps; this not to change the distribution of light, but on account of one of the poles obstructing the view of the tower men. This being the first large installation of flaming arc lamps in a railroad yard in this country, no data was available that could be used as a guide in locating the different lamps.

The entire installation, including distribution and erection of poles, feeders, etc., was made without interfering with the operation of the yard and without anyone being injured.

The different types of lamp suspension were considered, with the result that the lamps were installed on pole tops, designed for the installation. The arrangement of circuits is such that two ways are provided for supplying current to the lamps on the humps and in the classification yards. No duplication was attempted for the other yards, where cars could be moved without artificial illumination, if necessary.

The intensity of illumination secured equalled all expectations, and when the lamps were started up in the north half of the yard the effect produced was such that engineers on trains crossing the Eads and Merchants bridges, 12 miles away, could plainly see the illumination, and residents as far distant as ten miles telephoned to ask what was burning at Dupo. Since the system has been put in operation it has been possible to secure results in operating and policing the yard at night such as have never been approached elsewhere.

At the present time this yard is, without question, the best artificially illuminated railway freight yard in the country and the only one in which the results obtained give anything approaching a uniform intensity of illumination over the entire area.

RECORD EXCAVATIONS AT PANAMA.—All daily records for excavation in the Central Division were broken on March 11, when the total amount of material excavated within the limits of the Central Division aggregated 80,341 cu. yds. Of this amount, 79,484 cu. yds. were removed by 51 steam shovels and two orange-peel cranes, the latter excavating 1,191 cu. yds. of material from the Canal prism. The following amounts of material were removed from the different sections of the Central Division:

In the Chagres construction district, nine steam shovels of the 100-class and two orange-peel cranes excavated 13,331 cu. yds. of material.

In the Empire construction district, 20 shovels, excavated 27,374 cu. yds. of material, principally rock.

In the Culebra construction district, 21 shovels excavated 37,639 cu. yds. of rock and earth.

In the Pedro Miguel construction district, one shovel excavated 1,140 cu. yds. of rock.

In addition to these amounts, there were excavated by hand work 482 cu. yds., and by scraper 375 cu. yds.

Previous to the beginning of the present month, the highest daily record was made on April 8, 1909, on which date the total excavation within the limits of the Central Division aggregated 78,559 cu. yds. At this time, however, Lidgerwood flat cars were credited with a capacity of 20 cu. yds., place measurement, while at the present time they are counted as containing but 19 cu. yds., place measurement, although they are loaded as heavily as in 1909. Had figures now used for the contents of Lidgerwood cars been applied to the excavation of April 8, 1909, the output for the day would have aggregated 76,253 cu. yds., instead of 78,559 cu. yds., as was then reported, or about 4,000 cu. yds. less than the total excavation of March 11, 1911.—Canal Record, March 15, 1911.

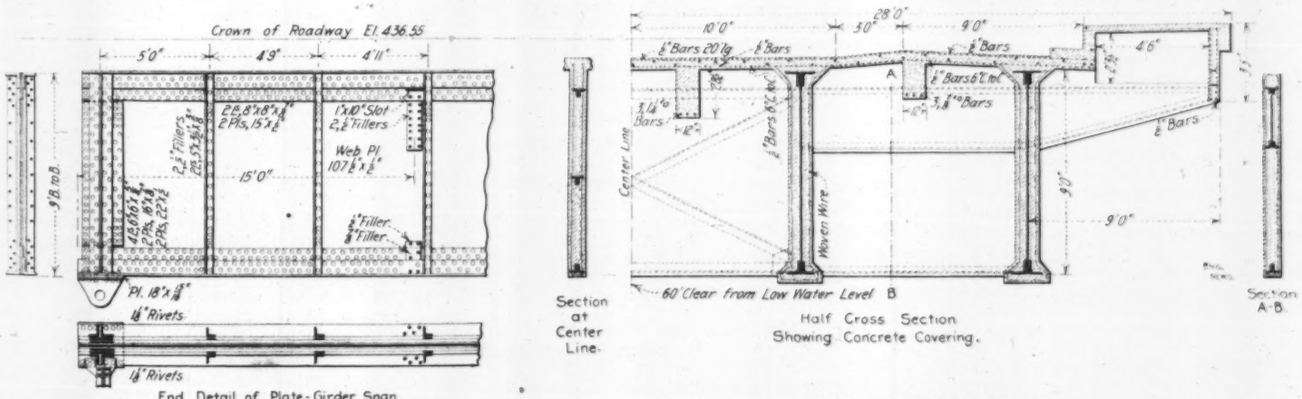

Crown of Roadway El. 436.55
Section at Center Line.
Half Cross Section Showing Concrete Covering.
Section A-B.
End Detail of Plate-Girder Span.

FIG. 8. DETAILS OF MIDDLE SPAN. STEEL PLATE GIRDERS COVERED WITH CONCRETE.

A Disastrous Factory Fire in a Ten-Story Fireproof Loft Building.

About 150 persons, most of them girls and women, were killed in a fire which gutted a shirt-waist factory occupying the three upper floors of a ten-story fireproof loft building in New York City on Saturday, March 25. Many of the victims lost their lives in jumping from the windows to the concrete sidewalks, or down a narrow light-court at the rear of the building, or down the elevator shafts. The others were burned to death in trying to reach the stairways, the doors to which opened inward.

The fire did not extend to adjoining buildings or to other floors of the building than the eighth, ninth and tenth, and did not do any substantial damage to the structural parts of the building. It was confined to burning out the contents of the three floors.

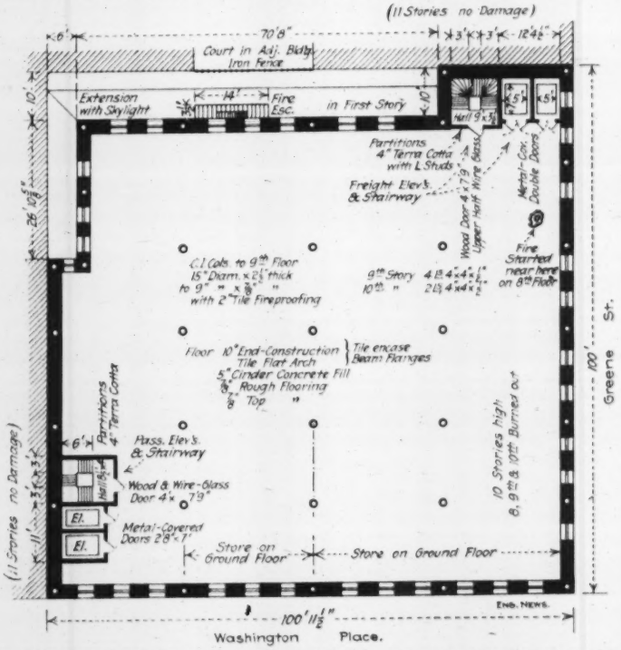
The three floors, occupied by the firm of Harris & Blanck, under the style of the Triangle Waist Co., were filled full of combustible and easily inflammable matter, consisting of parts and cuttings of cloth and finished shirt-waists. This explains the exceedingly rapid spread of the fire, as illustrated by the fact that while there was little delay in sending the alarm of fire the flames drove some of the employees to jump from the windows even before the first of the fire apparatus arrived. There were about 700 employees in the three stories.

The eighth and ninth floors contained each about 200 sewing machines in continuous rows on tables, and cutters' tables, etc. The tenth floor was used for packing and storing, and contained the offices.

The fire occurred shortly before 5 p. m., on Saturday, March 25. The employees had been paid off and the factory was within a few minutes of closing; some employees had already stopped work. Fire was noticed in waste material near the freight elevators at the Greene St. or east side on the eighth floor; the cause is not known at present. Attempts to put the fire out with buckets of water failed; the hose attached to a standpipe in the stair-shaft nearby was not used. The fire spread through the eighth floor with great speed. Either by beating out of the windows up and into the windows of the floor above, or by passing through the staircases or possibly through a pipe-shaft near the Greene St. staircase, it quickly went to the two floors above. There had never been any fire drill in the factory, and the workers had never been instructed as to exits or as to procedure in emergency. They soon were in thorough panic. Three of the four elevators continued to run for some time after the start of the fire and took down a large number of employees. Many of those in the tenth story, including the proprietors, Isaac Harris and Max Blanck, escaped up the stairs to the roof, whence they were helped up to adjoining roofs. Some few escaped by the fire-escape, located in the light court at the rear, though there was no ladder connection in the lowest story and there was no exit from the court to the street. The fire-escape was found partly wrecked after the fire, and as many of the victims jumped from the windows facing on this court it is likely that it was put out of service in the early part of the fire. The ninth floor seems to have provided most of the victims.

The drawing herewith shows the floor plan of the building, from a sketch based on the architect's original plans. The building stands at the northwest corner of Washington Place and Greene St., Manhattan Borough, in a territory filled with factories and ware-rooms of wearing apparel. It was built in 1900 under the 1899 Building Code (still in force). It is a typical fireproof loft building as built in Manhattan, and in most particulars meets the requirements of the law, except that its use for factory purposes had not been contemplated when the designs were approved. That it is fireproof as regards internal fires of moderate temperature and duration is shown by the small amount of structural injury in this fire.

As regards the equipment of the building for the safety of the occupants, it is stated by the Bureau of Buildings that three stairways are required under the Building Code (for buildings of 5,000 to 10,000 sq. ft. ground area), whereas only two are found in this building; on the other hand, the law does not require the stairways in fireproof buildings to be cut off from the interior by fireproof enclosures, and it is possible that the provision of such enclosures



FLOOR-PLAN OF ASCH BUILDING, WHERE 145 SHIRT-WAIST MAKERS WERE KILLED WHEN 8TH, 9TH AND 10TH STORIES BURNED OUT.

Sketch based on architect's plans as approved by and filed with the Bureau of Buildings, with added notes.
Entrances to building at west end of Washington Place side and north end of Greene St. side, at elevators. The Greene St. stairs continue to the roof; the Washington Place stairs end at the 10th floor.
Five standpipes in both stair shafts, with hose connections at each floor.
Building designed and built in 1900-1901.

and of an outside fire-escape was accepted by the Bureau in lieu of a third staircase. The fire-escape is not specifically demanded by the law, but when provided it must meet certain specifications, and must have a drop-ladder connection to the ground. Also, the present practice of the Bureau of Buildings is to require that a fire-escape in a court must communicate directly with the street by an open fireproof passage at the ground floor. The Bureau had not promulgated this rule at the time the building was constructed, but it would have been of little service in this instance to the occupants of the ninth and tenth floors, even aside from the wrecking of the fire-escape.

Only one stairway communicated with the roof, in which point it is claimed the law is fully satisfied. The doors leading into the stairshaft from the various floors are required by the Factory Laws to open outward where practicable. In this building they opened inward, and all the evidence is to the effect that this had do with checking the escape of the Moreover, several of the survivors hav that the doors were kept locked during hours, and Fire Chief Croker also sta All appearances indicate that they were This would be illegal, but the proprieto tively deny that any doors were locked known that the practice in many similar to keep the doors locked during workin in contravention of the Factory Laws.

The provisions of the Factory Laws to overcrowding prescribe a certain volume of room per occupant, but do on the spacing of workers on the floor arangement of aisles and exits. No exists between the number of stairs capes required, which are based on fl and the number of persons who may oc floor. The laws governing places of pu sembly are considerably more specific gent than those applicable to private ing establishments.

The building was designed and appro loft building, i. e., as a building for wa The owner and architect claim that not intend it for factory use. No gover bureau has any authority over change pancy from ware-room to manufacturing sufficiency of exits, etc., which would affected by such change, would come und isdiction of the city Bureau of Buildings. bureau has never engaged in regular supe or inspection of occupied buildings, nor ever been large enough to carry out even spection of new construction as thoroughly desirable.

The effects of the fire are practically con tained in the statement as to the number of victims and the statement that the three floors were entirely burned out. The windows seem have been burned away in most of the windows, and in a number even the frames were burned away. The three windows opening on the elevator shaft on the east or Greene St. side are intact, however, even to the glass.

Findings of the Court of Enquiry Into the Explosion of a Water-Tube Boiler on the Battleship "Delaware."

In Engineering News, Jan. 19, p. 88, we noted the failure of a water-tube boiler on board the U. S. Battleship "Delaware," due to the blowing out of three rear headers. The accident resulted in the death of eight firemen and coal passers out of a force of nine men on duty in the boiler-room. It will be remembered that the accident occurred about 9.15 A. M. Jan. 17, while the "Delaware" was bound for Norfolk, Va. The ship was proceeding under easy steam, but on account of poor draft the fire-rooms were closed and working under an air pressure of ¼-in. This was not more than good natural draft, so that the rate of combustion was about 18 lbs. of coal per sq. ft. of grate. The boiler was a Babcock & Wilcox marine water-tube type, with 4,425 sq. ft. of heating surface and 103 sq. ft. of grate surface. There were 14 boilers in all. On trial, the "Delaware" developed nearly 30,000 HP., so that this boiler when worked under forced draft had a capacity of over 2,000 HP.

It was reported that although the Captain was on deck at the time of the accident, he did not know that one had occurred until it was reported to him some minutes later. The explosion did not make noise enough to attract attention on the upper deck. The damage was confined to one boiler, the structure of the vessel not being injured at all. The boiler was repaired at Norfolk with new tubes and headers, most of the work being done by the engineering force of the ship.

The following letter concerning the findings of the Court of Inquiry has been made public by the Babcock & Wilcox Co., of New York City:

NAVY DEPARTMENT,
BUREAU OF STEAM ENGINEERING,
WASHINGTON, D. C.

March 11, 1911.

Gentlemen: In compliance with the request contained in your letter of Feb. 24, and with the approval of the

Department the Bureau submits for your information the following general statement of the finding and opinion of the Court of Inquiry appointed to inquire into the accident to boiler "O" of the "Delaware":

(a) The explosion occurred in boiler "O" Jan. 17, 1911, by which three rear headers Nos. 8, 9 and 10, were blown violently out of the boiler.

(b) These headers were found severely bowed, their tubes were bulged, and the metal showed signs of overheating. All the back headers of the outboard half of the boiler, 13 in number, were more or less bowed, the degree of distortion diminishing toward the outboard side of the boiler.

(c) The inboard half of the boiler was uninjured, and subsequent comment refers only to the outboard half.

(d) The 4-in. tubes next the fire were all more or less bowed at the back ends, and showed signs of having been bulged; and the majority of the 2-in. tubes were more or less distorted, while a number showed signs of having been white hot.

(e) The front headers were in good condition.

(f) The superheater tubes and manifolds showed a red color, and the 4-in. tubes through the first and second rows showed the blue color characteristic of overheating.

(g) On two of the headers blown out were found scores and dents made by the headers striking obstructions. The character of the scores and dents, and the blue color of the metal in the scores, indicated that the metal of the blown-out headers was in a softened condition, due to heat, when they struck.

(h) The three headers showed unmistakable signs of having been very hot. They showed the characteristic blue color following overheating, and the tube face of each had been bulged out by internal pressure, possible only when the metal is heated to a condition approaching redness.

(i) The greatest heat appeared to have existed at about the width of the height of the header, but the effects of overheating were manifest in all the back headers of the outboard half of the boiler, diminishing either way from the zone of greatest intensity of heat, which appeared to exist opposite the headers that were blown out.

(j) A number of 2-in. tubes of the blown out headers gave evidence of having been white hot. The surface of these tubes, near the back ends, appeared burned, and was covered with a coating of black oxide of iron. Signs of overheating were also in the outboard half of the drum, from which much of the soot had been burned off.

(k) From a consideration of the preceding facts, the Court concluded that the explosion was due to the lack of a sufficient quantity of water in the boiler, and that the water-tender on watch at the time was responsible for this condition. This opinion was strengthened by the fact that it was possible to enter the fire room with safety a very short time after the explosion occurred, which would not have been possible had the boiler contained the normal quantity of water.

(l) All testimony showed that the boiler was in good condition prior to the accident, and that the regulations regarding the care and preservation of boilers had been carried out; that other boilers which had been subjected to the same use were in good condition; and that the overheating noted in the injured boiler would have produced the results observed by the Court after the accident, no matter how perfect the boiler.

(m) From some testimony before the Court, the conclusion was reached that the reading of the water gages was misleading, although the gage glass fittings are recognized as simple and reliable; other testimony, however, led to the opinion that the opening of the feed check valve had been increased shortly before the accident occurred.

Very respectfully,
R. S. Griffin,
Acting Chief of Bureau.

The Babcock & Wilcox Co. has issued, with the above letter, the following brief comment:

The Court finds that only the outboard half of the boiler was damaged. It might seem at first glance as though it would be impossible for one-half of the boiler to be injured and the other escape. The explanation, however, is very simple. The feed water enters the boiler in the steam and water drum, which is above the front headers and connected to them by nipples, and is distributed through an internal feed pipe perforated with holes on its lower side. This pipe extends from the check valve at the inboard end of the drum to a short distance past the center of its length. As long as the water in the drum was above the tops of the nipples mentioned, it would not of course make any difference where the feed water was introduced, as it would naturally find its level. In case of low water, however, due to inadequate feed, the boiler might be under moderate combustion, just enough steam to save the inboard half of the boiler, where the water would go directly down the nipples, while only a few headers and associated tubes on the other side would get water. This appears to be the explanation of the salvation of the inboard side of the boiler.

Notes From Engineering Schools.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—A congress of technology will be held in Boston, Mass., April 10-11, 1911, in celebration of the semi-centennial of the granting of the institute's charter. Large numbers of alumni are expected to attend. The congress will be opened in Huntington Hall on Monday afternoon, April 10, with an address by President Maclaurin. Later in the afternoon a few selected papers will be read. An alumni smoker at Symphony Hall will occupy the evening. On April 11, there will be morning and afternoon sessions for the reading of papers on technical subjects. These sessions will be open to the public. The congress will be concluded on Tuesday evening with a banquet open to alumni and invited guests.

The advance list of papers to be presented shows a total of 53 papers by prominent alumni and members of the faculty. Among these papers are the following: "Scientific Management," David Van Alstyne ('86), Vice-President, Allis-Chalmers Co., Milwaukee, Wis.; "The Technical School Graduate: His Strength and His Weakness," Prof. H. P. Talbot ('85), of Massachusetts Institute of Technology; "The Chemist in the Service of the Railroad," H. E. Smith ('87), Chemist and Engineer of Tests, Lake Shore & Michigan Southern Ry., Collinwood, Ohio; "Sewage Disposal with Respect to Offensive Odors," Geo. W. Fuller ('90), of New York City; "Thirty Years' Work in Boiler Testing," Geo. H. Barrus ('74), of Boston, Mass.; "Some Phases of Modern Architectural Practice," Walter H. Kilham ('89), of Boston, Mass.; "The Technics of Iron and Steel," T. W. Robinson ('84), Vice-President, Illinois Steel Co., Chicago, Ill.; "Improvements in Efficiency of Electric Lighting Properties and what the Public Gains through these Improvements," Wm. H. Blood, Jr. ('84), of Boston, Mass.; "Reclamation of the Arid West," Frederick H. Newell ('85), Director, U. S. Reclamation Service, Washington, D. C.

UNIVERSITY OF MISSOURI.—Fire destroyed the Mechanic Arts building on the university campus March 23. The loss is estimated at $75,000.

A FIRE AT COLON, PANAMA, March 23, destroyed about 100 houses valued at $750,000, and eight canal labor camps valued at $25,000.

A FIRE IN THE NEW YORK STATE CAPITOL started at about 1 a. m., March 29, and in three hours had ruined the State Library and had destroyed a part of the western staircase. The fire was not gotten under control until about 7.30 a. m., after the entire western end of the building had been destroyed. The fire started on the third floor in the northwest corner. The State Library was on this floor, extending completely across the western wing. It contained about 160,000 volumes, together with valuable documents and records, all of which were destroyed. The State Education Department occupied the fourth floor, above the State Library. The Senate and Assembly chambers were not entirely destroyed, but were heavily damaged, the former chiefly by water. The Executive Chamber was also damaged by water. The total loss is estimated roughly at $6,000,000.

The construction of the Capitol, which covers three acres of ground, was begun in 1867 and it has never been entirely completed. A total of about $25,000,000 has been spent on it. The walls are of Maine granite.

A MINE CAR JUMPED THE TRACK March 22 in the Hazel mine of the Pittsburg & Buffalo Coal Co. at East Canonsburg, Pa., and knocked out some of the timbers supporting the roof. The roof fell on the ten men in the car, nine of whom were killed.

A BROKEN LOCOMOTIVE AXLE, according to the statement given out by officials of the Atlantic Coast Line Ry., was the cause of the wreck of the "Dixie Flyer," train No. 95, March 25, about 18 miles from Ocilla, Ga. The accident occurred at about 5 a. m. on a trestle over the Allapaha River. The baggage and express cars, two day coaches and one Pullman fell into the river, while five Pullmans remained on the rails. Ten persons were killed and some 20 others injured. The train had left Chicago, south-bound, at 9.50 p. m., March 23.

DYNAMITERS NEAR CLEVELAND, OHIO, March 25, succeeded in wrecking the ore-handling bridge of the Erie R. R.'s plant at North Randall, a Cleveland suburb. The estimated loss is $200,000. The plant was only recently completed and had been in operation but a few days. The work of erection was done under the open-shop plan by the Wellman, Seaver, Morgan Co., of Cleveland, and Heyl & Patterson, of Pittsburg, Pa. The latter firm is the same which erected the unloading derrick recently dynamited at Milwaukee, Wis., as noted in our issue of March 23.

AN OVERLOADED FLOOR COLLAPSED March 25 in a hay and feed store at 244 Howard Ave., Brooklyn, N. Y. Reports state that several hundred tons of hay, straw and oats had been hoisted to the second floor on the morning of the accident. The collapse occurred during the noon hour. Three men on the first floor were crushed and killed.

MESSERS. GAYNER AND GREENE, the contractors who have been serving a sentence at the Atlanta penitentiary for frauds in connection with the Savannah Harbor works, were released on March 24 after taking the "pauper's oath," swearing that they were financially unable to pay the $575,000 fine imposed upon each of them in addition to the prison sentence. The U. S. district attorney endeavored to prove that they had in hand sufficient funds secured by their fraudulent operations to pay these fines, but the U. S. Commissioner, before whom the case was brought, decided to the contrary, and allowed them to take the oath, and to go free. Their four-year sentence, with time deducted for good behavior, expired about a month ago.

THE COMMON DRINKING CUP is being brought under the ban by state and city boards of health in various parts of the country. The Board of Health of New York City at a meeting held on March 21, 1911, added a section to the Sanitary Code, to take effect Oct. 1, 1911, as follows:

Sec. 189. The use of a common drinking cup or receptacle for drinking water in any public place or in any public institution, hotel, theatre, factory, public hall or public school or in any railroad station or ferry-house in the city of New York, or the furnishing of such common drinking cup or receptacle for use in any such place is hereby prohibited.

According to a bulletin issued by the Department of Health of the City of New York, Commissioner Lederle states that the public drinking cup is now held to be a means of spreading a number of infectious diseases, including "diphtheria, scarlet fever, tonsilitis, colds, influenza, and perhaps, occasionally, tuberculosis, as well as syphilis." Commissioner Lederle also states that where public water-drinking facilities are provided there may be used individual cups (presumably paraffine paper or the like) or some one of the various types of drinking fountain "in which the lips of the drinker do not come into contact with the fountain itself."

THE RIGHT TO TAKE UNDERGROUND WATER out of New Jersey into New York has been denied by the New Jersey Court of Errors and Appeals in an injunction suit brought by the Borough of North Arlington against the New York & New Jersey Water Co. The injunction is sought on the grounds that the company named was laying water pipes in the streets of North Arlington without legal authority. In view of the fact that while it was alleged that the pipes were to convey water for Bayonne, N. J., the real object was to carry water to Staten Island, N. Y. The decision in the case is so interesting that we quote from it at considerable length as follows:

The facts displayed in the record lead to but one conclusion and that is that the contract under which the water company is laying its main from Belleville to Bayonne and there connecting it with the pipe of the Hudson Water Co. leading to the Kill von Kull, has for its principal object the transportation of subterranean waters from this state to the state of New York without, so far as we can discover, any lawful right to do so.

Such right is not claimed in the brief of the counsel of the complainants, but, on the contrary, it freely disavows such purposes and urges that the defendants have utterly failed to prove that it is intended to transport water to Staten Island or elsewhere out of the state of New Jersey.

It was evident that the principal purpose of the contract upon which the water company sought to lay its pipes was not to furnish Bayonne with an emergency supply. There was no proof that such a supply is needed, the only apparent consideration to the city being the supplying of water for municipal uses, free of charge, and the tolls provided for in the agreement of $5 per million gallons, which profit the company can only reap when water is taken out of the state. This situation deprives the city of any substantial interest in the contract, except as an assistant in the proposed scheme to transport water to New York.

We are of the opinion that under this contract the provision for an emergency supply is a subterfuge to cover the real purpose of the complainants, but granting that the city of Bayonne is entitled to lay a pipe through the borough of North Arlington for the purpose of providing Bayonne with water for an emergency supply, or other lawful purpose, its right to do so is limited to the installation of a pipe reasonably sufficient for the purpose, and it cannot take advantage of such right to lay at the same time a pipe of a capacity sufficient to supply Bayonne and also the borough of Richmond in the state of New York, any more than it would have the right to put down two pipes in the trench proposed, one to carry water to Bayonne and the other to convey water out of the state, and so far as the contract requires the laying of a pipe sufficiently large to supply the borough of Richmond, it is ultra vires.

It is urged that as the water cannot be lawfully transported out of the state, it will not be inferred that a wrong is intended, and therefore it is not unlawful to

lay a pipe sufficiently large to supply the borough of Richmond as well as the city of Bayonne, in anticipation of the removal of the present legal prohibition, but that begs the question, which is the present right of the complainant to use the highway in North Arlington in the manner proposed under the contract invoked in support of that right, for if a pipe of the size, and for the purpose contracted for, is not being installed by virtue of a present legal authority, the complainants have no standing in a court of equity.

Personals.

Mr. W. C. Knighton, of Portland, Ore., has been appointed State Architect of Oregon at a salary of $4,500 per annum. He will have charge of all the architectural work on public buildings erected by the state, and is to devote his entire time to this work.

Mr. Sidney S. Stone, Superintendent of the Morris & Essex Division of the Delaware, Lackawanna & Western R. R., has resigned, to take effect April 1.

Mr. T. A. Sweeney, formerly Train Master at Des Moines, Iowa, has been promoted to Assistant Superintendent of the Eastern Division at Chicago, Ill.

Mr. George J. Gould has resigned as President of the Missouri Pacific Ry. and was elected Chairman of the Board of Directors. No one has yet been selected to fill the presidency.

Mr. Chas. S. Clarke, First Vice-President of the Missouri Pacific Ry., has resigned, to take effect upon the election of a President to succeed Mr. George J. Gould, who recently resigned.

Mr. Burt R. Rickards, for the past three years Chief of Laboratories for the Ohio State Board of Health, of Columbus, Ohio, has been appointed Associate Professor of Municipal and Sanitary Dairying at the Agricultural College of the University of Illinois.

Mr. Morris Knowles, M. Am. Soc. C. E., a consulting engineer of Pittsburg, Pa., has been placed in charge of the course in Sanitary Engineering at the University of Pittsburg. This course will be developed in cooperation with the Medical School of the University and the Departments of Health of the city and state.

Col. W. R. Felker has resigned as President of the Kansas City & Memphis Ry. He will devote his entire time to the construction of the new line to Fayetteville and Memphis, for which the W. R. Felker Construction Co. has the contract for building and equipping. He is succeeded as President by Mr. George D. Locke, former Vice-President.

Mr. F. B. Maltby, M. Am. Soc. C. E., of Syracuse, N. Y., has resigned as General Superintendent of James Stewart & Co. to become associated as Chief Engineer and General Manager with Gahren & Dodge, General Contractors, under the new name of Gahren, Dodge & Maltby, Construction Engineers, with office at 29 Broadway, New York City.

Mr. E. S. Koller, Superintendent of the Chicago, Burlington & Quincy R. R., at McCook, Neb., has been appointed General Superintendent at Galesburg, Ill. He is succeeded at McCook by Mr. E. Flynn, who is transferred from the Omaha Division. Mr. A. G. Smart, formerly Train Master at McCook has been promoted to Superintendent at Omaha.

Obituary.

Maj. Walter H. Laurie, M. Can Soc. C. E., died on March 17, on a train while en route to Sydney, Nova Scotia. He was 60 years old and a native of Canada, of Scotch descent. He was the founder of the Laurie Engine Works, from which he retired five years ago and formed the firm of Lamb & Laurie, consulting engineers. He is survived by a widow and four children.

Hale D. Judson, General Superintendent of the Illinois District of the Chicago, Burlington & Quincy R. R., died on March 19, at Brockport, Tex. He was born on May 30, 1853, at Waupaca, Wis., and entered the railway service as a telegraph operator in 1872, on the Chicago & Iowa R. R. He became General Superintendent of this road, and after its absorption by the Chicago, Burlington & Quincy R. R., became Superintendent of the Chicago Division of the latter. He had been General Superintendent of the Illinois District since 1904.

W. Fred. Main, a well-known salesman of the Chicago Portland Cement Co., died at his home in Chicago, Ill., on March 15. He was born in Chicago in 1855 and attended the public schools of that city. He was first associated with the Republic Fire Insurance Co., and later with the Payson Mfg. Co., of which he was at one time Treasurer. He sold his interest in this company in 1902 and had since been with the Chicago Portland Cement Co. He was a member of the National Association of Cement Users and similar organizations.

Dr. Samuel Franklin Emmons, M. Am. Inst. M. E., Geologist of the United States Geological Survey since 1879, died at his home in Washington, D. C., on March 28. He was born in Boston, Mass., on March 29, 1841. He graduated from Harvard University in 1861, and from 1862 to 1864 he attended the Ecole Impériale des Mines at Paris, and in 1864-65 the Bergakademie at Freiburg. He was Geologist for the United States on the exploration of the 40th parallel from 1867 to 1877. He had been General Secretary of the International Geological Congress for the past 20 years. He was a member of many learned and scientific societies of both this country and abroad. He was an honorable member of the Canadian Mining Institute. Dr. Emmons was the author of several books and papers, and was one of the most eminent authorities in this country on geology and mining.

Charles Wallace Hunt, Past-President of the American Society of Mechanical Engineers, President of the C. W. Hunt Co. and other industrial concerns, died at his home on Staten Island, N. Y., on March 27. He was born in Candor, Tioga County, N. Y., on Oct. 13, 1841. He received both an elementary and a scientific course at Cortland Academy, Horner, N. Y. In 1864-65 he was a special agent for the War Department to care for freedmen escaping from the Southern to the Union lines. In 1872, he started in the business of building coal handling machinery at West New Brighton, Staten Island. The various devices invented, patented and built by Mr. Hunt have in many respects revolutionized the handling of coal. Branch works for the manufacture of his devices are in operation in England and Germany. He was also engaged in the construction of wharves, docks, storage warehouses, power stations and industrial equipments for many purposes. He was also a member of the American Institute of Mining Engineers, an Associate of the American Institute of Electrical Engineers, a member of the American Association for the Advancement of Science and many others.

Frederick Livingston Hart, M. Am. Soc. M. E., died at the home of his brother-in-law, Dr. Ralph D. Macfarland, in Jamaica, N. Y., on March 23. He was born in Brooklyn, N. Y., on July 3, 1861. He graduated from Brooklyn Polytechnic Institute and was first employed at the engineering works of William Wright at Newburgh, N. Y. He was later connected with the United States Electric Lighting Co., of Newark, N. J., and was appointed Engineer in charge of installing and operating the electric plant of the New York and Brooklyn Bridge. For a number of years he was Superintendent of Operation of the 125th St. & Tenth Ave. Ry. Co., which position he resigned to become Engineer for the Metropolitan Ry. Co. Two years later he became Manager of the Baltimore City Passenger Ry. After holding this position for 6 years, he resigned to become General Manager of the Washington Railway & Electric Co., of Washington, D. C. After two years in Washington he returned to Baltimore and became associated with the firm of Thomas Basshoe, Contracting Engineers. Failing health compelled him to give up this position and he returned to his home in Brooklyn. He leaves a father, brother, two sisters and a daughter.

Engineering Societies.

COMING MEETINGS.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 6-8. Annual meeting at New York City. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Chattanooga, Tenn. Secy., D. B. Sebastian, 721 La Salle Station, Chicago, Ill.

AMERICAN RAILWAY ASSOCIATION.
May 17. Semi-annual meeting at New York City. Secy., W. F. Allen, 24 Park Pl., New York City.

OHIO SOCIETY OF MECHANICAL STEAM AND ELECTRICAL ENGINEERS.
May 18-19. Annual convention at Youngstown, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 23-25. Annual meeting at New York City. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 23-26. Annual convention at Chicago, Ill. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 23-26. Annual convention at Pittsburg, Pa. Secy., Richard Moldenke, Watchung, N. J.

INTERNATIONAL MASTER BOILERMAKERS' ASSOCIATION.
May 23-26. Annual convention at Omaha, Neb. Secy., H. D. Vought, 62 Liberty St., New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 29-June 2. Annual convention at New York City. Secy., T. C. Martin, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 30-June 2. Annual convention at Pittsburg, Pa. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN WATER WORKS ASSOCIATION.
June 6-10. Annual convention at Rochester, N. Y. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 6. Annual convention at Glenn Summit Springs Hotel, Luzerne Co., Pa. Secy., R. W. Raymond, 29 West 39th St., New York City.

ALBANY SOCIETY OF CIVIL ENGINEERS.—An informal address describing interesting features of the Catskill Aqueduct was given at the meeting of March 28 by Mr. Robt. Ridgeway, Department Engineer, New York Board of Water Supply.

SUPPLY AND MACHINERY DEALERS ASSOCIATIONS.—A triple joint convention of the Southern, the National and the American associations will be held at Louisville, Ky., April 3-5. Addresses of we[lcome] will be made at the opening session by Augustus [Willson], Governor of Kentucky, and W. O. Hea[d], Mayor of Louisville. Among the excursions planned [is a trip to] the Mammoth Cave.

ASSOCIATION FOR STANDARDIZING [PAVING] SPECIFICATIONS.—This is te new and shorte[r title of] the former Organization of City Officials for St[andardizing] Paving Specifications. The proceedings of [the annual] meeting held at New York in January are [now pub]lished (copyright). Information as to the [Association] and its specifications may be obtained from t[he Secretary,] Mr. John B. Hittell, Chief Engineer of S[ts, City] Hall, Chicago.

AMERICAN INSTITUTE OF MINING EN[GINEERS.—] The fall meeting and excursion is to be [held at San] Francisco, Cal., beginning Oct. 10. A specia[l train from] Chicago to San Francisco is proposed wit[h visits en] route to Del Monte, Santa Barbara, Los Ang[eles and the] Grand Canyon of the Colorado in Arizona. [An excur]sion to Japan is contemplated for a party o[f about 100] members and guests. The excursion party, [according to] the present plans, will sail from San Franci[sco Oct. 17] and remain in Japan 18 days, sailing from [Yokohama] on the return trip Nov. 21.

AMERICAN FOUNDRYMEN'S ASSOCIATION.—The annual convention at Pittsburg, Pa., May 22-26 will be held in conjunction with the conventions of the American Brass Founders' Association and the Associated Foundry Foremen. Among the papers to be presented are the following: "Use of Borings in Cupolas," "Permanent Molds," "Vanadium in Non-Ferrous Alloys," "Determination of Nickel in Bronzes," "Founding High Grade Bronzes," "Rotary Blowers," "Heating and Lighting Systems," "Pattern Making," "Molding Machines," "Electric and Converter Furnaces for Steel Castings," "Effect of Vanadium and Titanium on Steel," "Corrosion of Brass Foundry Products," "Pyrometry in the Aluminum Foundry." The exhibition of the Foundry & Machine Exhibition Co. will be open throughout the day and evening on the Saturday following the convention, May 27.

SOCIETY OF ENGINEERS OF NORTH CENTRAL WASHINGTON.—An organization under this name was effected March 11 at a meeting held at Okanogan City, Wash. Its chief purposes are to establish and enforce uniform methods in the practice of civil engineering and surveying, to secure cooperation between members so as to avoid needless duplication of work and to establish uniform scales of remuneration. A plan was adopted whereby all members might recognize survey marks set by other members, and it was agreed that any member would accept such marks as a basis for further work. It was agreed also that each member should have access to all notes and records in the possession of the others. Officers were elected as follows: President, F. A. McGuin, of Conconully; Vice-President, G. H. Wheeler, of Conconully; Secretary-Treasurer, W. C. Muldrow, Okanogan City, Wash.; Directors, F. C. Paine, of Okanogan, and M. M. Griswold, of Omak.

AMERICAN WATER WORKS ASSOCIATION.—The "question box" circular presents 21 questions for discussion at the 31st annual convention at Rochester, N. Y., June 6-10. Among the subjects of the questions are the following: 1—Treatment of water supply for boiler feed separately from supply for general uses. 2—Advantages of power-driven trench pumps in laying mains or making repairs. 4—Experience with fuel oil and its advantages compared with coal. 5—Proper depth to lay mains to prevent freezing. 6—Cause and remedy for red or rust color in hot water. 9—Experience with pneumatic caulking tools on cast-iron pipe joints. 10—Metering of free public water-supplies, as to city buildings, etc. 11—Prevention of electrolysis. 13—Experience with hypochlorite as a purifier of water supplies. 14—Use of leadite for water-pipe joints. 17—Unauthorized tapping of fire services. 19—Success of the steam-turbine direct-connected pump. 20—Under-registration of water-meters. 21—Location of leaks under pavements having concrete foundations.

NATIONAL CONFERENCE ON CITY PLANNING.—The third conference will be held at Philadelphia, Pa., May 15-17. Six sessions will be held at which a total of seven topics will be discussed. One of these is "Street Widths and Their Subdivision for Various Purposes" (first session), which will be presented by Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York City; John Nolan, of Cambridge, Mass., and Charles Mulford Robinson, of Rochester, N. Y., and will be discussed by Geo. S. Webster, of Philadelphia, Pa., and Geo. W. Tillson, Chief Engineer of Highways, Borough of Manhattan, New York City. Another topic is "The Dock Problem" (fifth session), which will be presented by Calvin Tomkins, Commissioner of Docks, New York City; Joseph Hasskarl, Director of Docks, Wharves and Ferries, Philadelphia, Pa.; T. E. Gibbon, President of Dock Commission, Los Angeles, Cal., and Geo. C. Sikes, former Secretary of the Chicago Harbor Commission. The secretary of the conference is Mr. Flavel Shurtleff, 19 Congress St., Boston, Mass.